the Petroleum Engineer

FOR MANAGEMENT

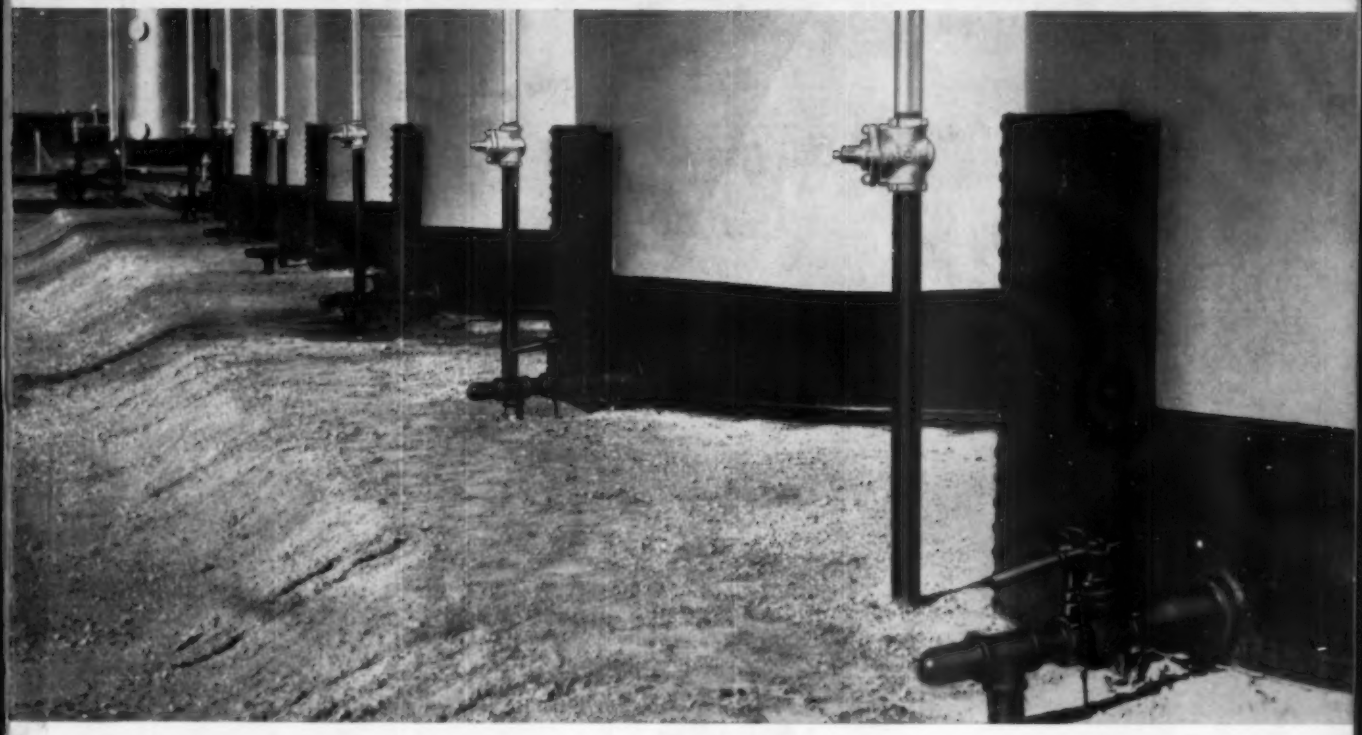
You Can Solve That Problem!

Communications: Creative Thinking in Business

The Classroom That Isn't

Oil and the Independent Operator

INTEGRATED EDITION OF THE PETROLEUM ENGINEER



DWARFS IN SIZE . . . GIANTS IN IMPORTANCE

Valves are usually small in comparison to the size of the units they control. But a leaking 2″ valve can cost you just as much in product loss as a hole in a 60 foot storage tank.

In Rockwell-Nordstrom valves, pressurized lubricant sealing guards your profits with a leakproof dependability that can't be matched by ordinary valves. You'll get trouble-free flow control, too, because lubricant jacks the plug for *instant*, quarter-turn operation even when the valve has been open or closed for months.

Rockwell-Nordstrom valves are available in a full range of sizes and pressure ratings. They cost no more to buy, often less, than ordinary valves—and they'll always save you money. Write for more details: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF

40th YEAR *of lubricated plug valve leadership*

Contents Pages 2-3 • Ad Index Page 6

AUGUST 1956

One Dollar A Copy

Dowell engineers use modern equipment to clean up pay zone with Mud Acid before a fracturing job.

Mud Acid clears the way for fracturing

Mud-caked formation surfaces can balk every fracturing effort, resisting the passage of fluids and causing excessive treating pressures.

Dowell engineers have a solution to many such problems—a spearhead of Mud Acid. With its mixture of hydrochloric and hydrofluoric acids, Mud Acid is designed to dissolve clay minerals and to prevent the swelling of bentonitic materials. It also dissolves any material soluble in hydrochloric acid, such as limestones and dolomites.

When Mud Acid has done its work, fracturing fluids are able to enter the formation at lower pressures and increased injection rates can be obtained. Mud Acid contains a Dowell inhibitor to help protect well equipment from acid corrosion, even at temperatures above 300°F. Special additives help prevent emulsions.

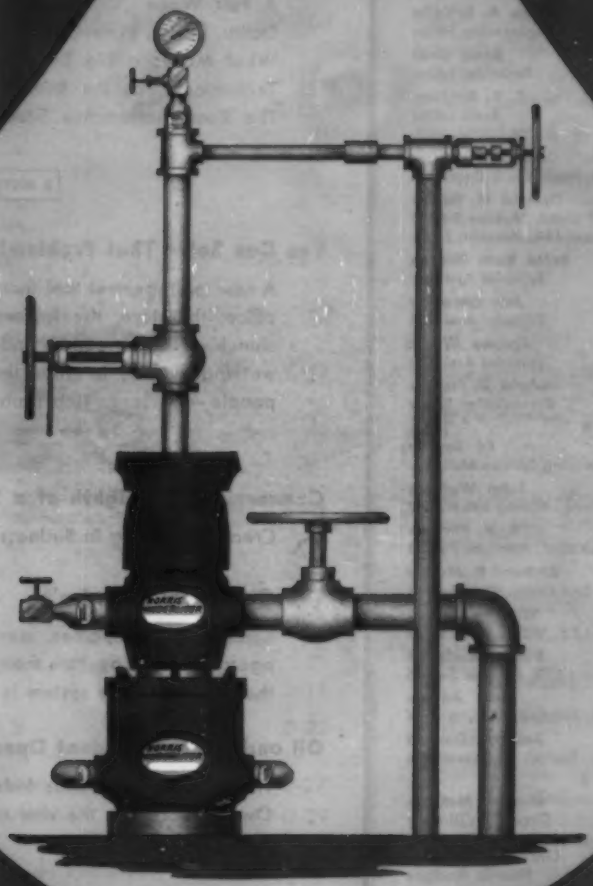
For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, Dept. H-12.

services for the oil industry DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

If OIL is Your Business...

You Need NORRIS-HINDERLITER WELL HEAD EQUIPMENT



Your SUPPLY STORE IS OUR DISTRIBUTOR

W.C. NORRIS MANUFACTURER, INC.

TULSA, OKLAHOMA

BRANCHES:

GREAT BEND, KANSAS; CORPUS CHRISTI, HOUSTON, KILGORE, ODESSA, WICHITA FALLS, TEXAS

Since NORRIS 1882

OKLAHOMA CITY, OKLAHOMA
SALEM, ILLINOIS; CASPER, WYOMING

WEST COAST DIST.: REPUBLIC SUPPLY CO. OF CALIF., LOS ANGELES

A Magazine of Petroleum Management

the Petroleum Engineer

FOR MANAGEMENT

NUMBER 9 VOLUME XXVIII AUGUST, 1956

The Conference Table A-10

A Fair Wage
Dollar, Dollar, Who Gets the Dollar?
What Makes a Big Executive?
Technology Ups the Boom
The Rhamphorhynchus Situation

E SECTION FOLLOWS A

You Can Solve That Problem! E-3

A new management tool that can be used any place — in the office, the store, the factory, the home, the civic club, the church — in a group or individually. A practical method of working out any question that confronts you in dealing with people — a seven-step path to the best possible action

—Dallas Belcher

Communication: Eighth of a Series E-7

Creative Thinking in Business — *Dennis Murphy*

The Classroom That Isn't E-11

Some 2000 companies, many in the oil industry, help teenagers form and operate their own companies — to learn what the free enterprise system is by putting it to work

Oil and the Independent Operator E-13

The president of Texas Independent Producers and Royalty Owners describes the vital role of the independent.

— A. E. Herrmann

DRILLING AND PRODUCING

Problems in Completing High-Pressure Gas Wells B-21
J. M. Tharp and J. E. Bailey

DRILLING FUNDAMENTALS

Power Transmission B-28
Allan B. Fredhold, Jr.

Tidelands Ownership Question Stymies New Drilling B-38
C. R. Graham

Joe B. Woods
President and Publisher
Abbott Sparks
Vice President and Advertising Director
Frank H. Love
Vice President and Editorial Director
L. H. Johnston
Secretary-Treasurer

•

Ernestine Adams
Management Editor
J. E. Kastrop
Editor, Drilling, Producing, and Exploration
Arch L. Foster
Editor, Refining, Petrochemical and Gas Processing
Frank H. Love
Editor, Oil, Gas, and Products Pipelining
James A. LeVelle
Engineering Editor
Dean Hale
Technical Editor
C. R. Graham
Field Editor
Jerry Stumm
Editor, Pacific Coast, RYan 1-5024
1011 S. Madison, Pasadena 5, California
Donald M. Taylor
Editor, Gulf Coast, JAckson 3-6346
2370 Rice Blvd., Room 110, Houston, Texas
Bette Ruth Horton
Editorial Assistant
Jan Gartman
Editorial Assistant
Jeanne Wertz
Editorial Assistant
Donald D. Fickert
Presentation Editor

•

Ed Sealey
Advertising Service Manager
NEW YORK— **John Wallace**
52 Vanderbilt Ave., MUrray Hill 6-7232
CHICAGO— **E. V. Perkins**
53 West Jackson Blvd., HArrison 7-6883
PASADENA— **Richard P. McKay**
465 East Union, RYan 1-8779
PITTSBURGH— **William Faville**
4525 McKnight Rd., WEllington 1-0619
HOUSTON— **Roger Motheral**
2370 Rice Blvd., Room 110, JAckson 3-6346
DALLAS— **Jess Adkins**
800 Davis Building, STerling 4404
John McDonald
Special Representative

•

Charles McKean
Circulation Director
Royal Courtney
Circulation Manager
Morris Hodges
Production Manager
Bobbie Robinson
Assistant Production Manager

Copyright 1956

The Petroleum Engineer Publishing Company
Indexed by Industrial Arts Index and The Engineering Index, Inc.
Member of Audit Bureau of Circulation and Associated Business Papers

The Petroleum Engineer for Management, published monthly, August through June, semi-monthly in July, by The Petroleum Engineer Publishing Company, 800 Davis Building, Dallas 2, Texas. Subscription rate to the Petroleum Industry, United States, Canada, and Foreign, $6.00 per year; $10.00 for 2 years; $13.00 for 3 years; $1.00 for single copy. Entered as second-class mail matter May 1, 1932, at the post office in Dallas, Texas, under the act of March 3, 1879.

PRODUCTION FUNDAMENTALS
Considerations for Single Zone Completions ... B-40
C. L. Rawe
New Offshore Diesel-Electric Rig ... B-52
Don Taylor
240 Tons Equipment Flown to Jungle Wildcat ... B-60
Corrosion Protection of Oil Well Casing ... B-64
W. C. Koger
Acid Spearhead Helps To Increase Fracturing Efficiency ... B-74
J. K. Henderson
Drafting Department Gets 'New Look' ... B-83
John Morris
Desirable Pumping Unit Speeds ... B-86
Charles L. Coffman
Down-Hole Chambers Increase Gas-Lift Efficiency—Part 2 (Conclusion) B-91
H. W. Winkler and George F. Camp
Electrical Resistivities of Oil Field Brines — Part 2 ... B-104
Murphy E. Hawkins and J. L. Love
Aluminum Pipe in Oil Field Operations ... B-116
New Offshore Drilling-Contracting Firm ... B-136

REFINING AND PETROCHEMICAL
Electrical System in New Petrochemical Plant C-3
R. C. Berger
Recovery of Refinery Slop Oil by Filtration C-9
Antoine F. Alciatore
New Viscosity Index En Route to Adoption: Part 2 . . . . . C-12
C. M. Larson and W. C. Schwaderer
Addition Agents for Lubricants: Part 3 . . . . . C-17
C. J. Boner
Furnace-In-Sky Sets Pattern for Vessel Stress Relief C-23
P. C. Arnold
REFINING FUNDAMENTALS
Mechanical Division: II Selecting Equipment C-26
REFINING IN BRIEF
Jet Engines and Their Probable Future C-41
William P. Barnes

OIL AND GAS PIPELINING
First Automatic Compressor Station D-16
Modern Design of Oil Pipe Lines — Part 3 . . . . . D-22
Fritz Karge
Taped Tickets Eliminate Bookkeeping Burdens D-27
Time Code Control and Data Handling Systems D-29
Paul K. Eckhardt
Compressor Station Incorporates New Design Features D-33
Henry Farnsworth and Jerry Shumm
Finding Buried Gas Leaks D-38
J. P. Sherwin
Cleaning Pipe Lines With Chemicals D-43
Harold R. Quinn
When Does a Corrosion Program Pay? D-45
Karl T. Feldman and Ralph J. Osborn
Cooling System Control D-49
How's Your Doctor? D-51
O. C. Mudd
Pipe Line Microwave Systems: Detailed Information D-56
Pipe Line Microwave System Map . . . . . Supplement

FEATURES

The Course of Oil ... A-4
Who Represents Customers?
Advertisers' Index ... A-6
Petroleum Profile ... A-8
L. F. McCollum
Highlights ... A-12
Meetings ... A-14
Laugh With Barney ... E-16
General Personals ... E-17
Women at Work ... E-22
Oil and Gas Trade News ... E-24
Trade Personals ... E-30
Of Things To Come in Oil ... B-3
The Oasis ... B-118
Books ... B-130
Exploration Activities ... B-138
What's Doing in Drilling ... B-142
Running Tour With Men in the Industry ... B-146
Pipe Line Developments ... D-3
Pipe Line Personals ... D-59

Four Editions
Published Monthly by
The Petroleum Engineer
Publishing Company
800 Davis Building
Dallas 2, Texas

A Magazine of Petroleum Management

the Petroleum Engineer

FOR MANAGEMENT

NUMBER 9 VOLUME XXVIII AUGUST, 1956

The Conference Table A-10

A Fair Wage
Dollar, Dollar, Who Gets the Dollar?
What Makes a Big Executive?
Technology Ups the Boom
The Rhamphorhynchus Situation

E SECTION FOLLOWS P

You Can Solve That Problem! E-3

A new management tool that can be used any place — in the office, the store, the factory, the home, the civic club, the church — in a group or individually. A practical method of working out any question that confronts you in dealing with people — a seven-step path to the best possible action

—Dallas Belcher

Communication: Eighth of a Series E-7

Creative Thinking in Business — *Dennis Murphy*

The Classroom That Isn't E-11

Some 2000 companies, many in the oil industry, help teen-agers form and operate their own companies — to learn what the free enterprise system is by putting it to work

Oil and the Independent Operator E-13

The president of Texas Independent Producers and Royalty Owners describes the vital role of the independent.

— A. E. Herrmann

DRILLING AND PRODUCING

Problems in Completing High-Pressure Gas Wells B-21
J. M. Tharp and J. E. Bailey

DRILLING FUNDAMENTALS

Power Transmission B-28
Allan B. Fredhold, Jr.

Tidelands Ownership Question Stymies New Drilling B-38
C. R. Graham

Joe B. Woods
President and Publisher
Abbott Sparks
Vice President and Advertising Director
Frank H. Love
Vice President and Editorial Director
L. H. Johnston
Secretary-Treasurer

•

Ernestine Adams
Management Editor
J. E. Kastrop
Editor, Drilling, Producing, and Exploration
Arch L. Foster
Editor, Refining, Petrochemical and Gas Processing
Frank H. Love
Editor, Oil, Gas, and Products Pipelining
James A. LeVelle
Engineering Editor
Dean Hale
Technical Editor
C. R. Graham
Field Editor
Jerry Stumm
Editor, Pacific Coast, RYan 1-5024
1011 S. Madison, Pasadena 5, California
Donald M. Taylor
Editor, Gulf Coast, JAckson 3-6346
2370 Rice Blvd., Room 110, Houston, Texas
Bette Ruth Horton
Editorial Assistant
Jan Gartman
Editorial Assistant
Jeanne Wertz
Editorial Assistant
Donald D. Fickert
Presentation Editor

•

Ed Sealey
Advertising Service Manager
NEW YORK— John Wallace
52 Vanderbilt Ave., MUrray Hill 6-7232
CHICAGO— E. V. Perkins
53 West Jackson Blvd., HArrison 7-6883
PASADENA— Richard P. McKay
465 East Union, RYan 1-8779
PITTSBURGH— William Faville
4525 McKnight Rd., WEllington 1-0619
HOUSTON— Roger Metheral
2370 Rice Blvd., Room 110, JAckson 3-6346
DALLAS— Jess Adkins
800 Davis Building, STerling 4404
John McDonald
Special Representative

•

Charles McKean
Circulation Director
Royal Courtney
Circulation Manager
Morris Hodges
Production Manager
Bobbie Robinson
Assistant Production Manager

Copyright 1956

The Petroleum Engineer Publishing Company
Indexed by Industrial Arts Index and The Engineering Index, Inc.
Member of Audit Bureau of Circulation and Associated Business Papers

The Petroleum Engineer for Management, published monthly, August through June, semi-monthly in July, by The Petroleum Engineer Publishing Company, 800 Davis Building, Dallas 2, Texas. Subscription rate to the Petroleum Industry, United States, Canada, and Foreign, $6.00 per year; $10.00 for 2 years; $13.00 for 3 years; $1.00 for single copy. Entered as second-class mail matter May 1, 1932, at the post office in Dallas, Texas, under the act of March 3, 1879.

PRODUCTION FUNDAMENTALS
Considerations for Single Zone Completions ... B-40
C. L. Rowe
New Offshore Diesel-Electric Rig ... B-52
Don Taylor
240 Tons Equipment Flown to Jungle Wildcat ... B-60
Corrosion Protection of Oil Well Casing ... B-64
W. C. Koger
Acid Spearhead Helps To Increase Fracturing Efficiency ... B-74
J. K. Henderson
Drafting Department Gets 'New Look' ... B-83
John Morris
Desirable Pumping Unit Speeds ... B-86
Charles L. Coffman
Down-Hole Chambers Increase Gas-Lift Efficiency—Part 2 (Conclusion) B-91
H. W. Winkler and George F. Camp
Electrical Resistivities of Oil Field Brines — Part 2 ... B-104
Murphy E. Hawkins and J. L. Love
Aluminum Pipe in Oil Field Operations ... B-116
New Offshore Drilling-Contracting Firm ... B-136

REFINING AND PETROCHEMICAL
Electrical System in New Petrochemical Plant C-3
R. C. Berger
Recovery of Refinery Slop Oil by Filtration C-9
Antoine F. Alciatore
New Viscosity Index En Route to Adoption: Part 2 . . . . . C-12
C. M. Larson and W. C. Schwaderer
Addition Agents for Lubricants: Part 3 . . . . . C-17
C. J. Boner
Furnace-In-Sky Sets Pattern for Vessel Stress Relief C-23
P. C. Arnold
REFINING FUNDAMENTALS
Mechanical Division: II Selecting Equipment C-26
REFINING IN BRIEF
Jet Engines and Their Probable Future C-41
William P. Barnes

OIL AND GAS PIPELINING
First Automatic Compressor Station D-16
Modern Design of Oil Pipe Lines — Part 3 . . . . . D-22
Fritz Karge
Taped Tickets Eliminate Bookkeeping Burdens D-27
Time Code Control and Data Handling Systems D-29
Paul K. Eckhardt
Compressor Station Incorporates New Design Features D-33
Henry Farnsworth and Jerry Shumm
Finding Buried Gas Leaks D-38
J. P. Sherwin
Cleaning Pipe Lines With Chemicals D-43
Harold R. Quinn
When Does a Corrosion Program Pay? D-45
Karl T. Feldman and Ralph J. Osborn
Cooling System Control D-49
How's Your Doctor? D-51
O. C. Mudd
Pipe Line Microwave Systems: Detailed Information D-56
Pipe Line Microwave System Map . . . . . Supplement

FEATURES

The Course of Oil ... A-4
Who Represents Customers?
Advertisers' Index ... A-6
Petroleum Profile ... A-8
L. F. McCollum
Highlights ... A-12
Meetings ... A-14
Laugh With Barney ... E-16
General Personals ... E-17
Women at Work ... E-22
Oil and Gas Trade News ... E-24
Trade Personals ... E-30
Of Things To Come in Oil ... B-3
The Oasis ... B-118
Books ... B-130
Exploration Activities ... B-138
What's Doing in Drilling ... B-142
Running Tour With Men in the Industry ... B-146
Pipe Line Developments ... D-3
Pipe Line Personals ... D-59

Four Editions
Published Monthly by
The Petroleum Engineer
Publishing Company
800 Davis Building
Dallas 2, Texas

AUTOMATION NEEDS MEN

One reason given by Steelworkers' McDonald for refusal to sign a long term labor contract was because of increase in automation of factories and mills. At the same time the demand is mushrooming for people trained, or willing to train, to man and service automatic control systems of industry.

In our expanding economy automation means up-grading of labor, increased production efficiency, higher living standards. The adjustments may be uneven but you can't fight progress in a dynamic economy. All industrial relations should be bent on smoothing the way to greater automation.

DO-IT-YOURSELF ENTERPRISE

Today's youth has a better opportunity than ever before to learn the economics of private capital enterprise. Recently a high school class chipped in and bought a share of stock to see what being a stockholder was like and to watch their money being used as capital by the company.

One movement that shows great promise in preparing young people for modern business is Junior Achievement. (See Page E-11). In this project high school pupils organize a corporation, sell stock, manufacture a product or provide a service, find customers, pay dividends, etc. They are advised by businessmen but make their own decisions. They learn at first hand what a corporation is for and how it works.

Junior Achievement is a worthy project for any company. It lays a foundation for tomorrow's businessmen. It provides good communications for better public relations. It is something you should look into this year if you haven't already.

WHO REPRESENTS CUSTOMERS?

As war is diplomacy's failure so a strike is the failure of industry relations. Nor does the parallel end there. Nobody wins a strike just as nobody wins a war.

The steel strike was reportedly called when differences between management and labor were the period of the contract and 5 cents an hour in wages.

On one side of negotiations in this dispute, which affected everybody in the nation, was David J. McDonald, leader of the Steelworkers union, and on the other were representatives of U. S. Steel, Bethlehem and Republic. After a month's talks, a strike was called by McDonald.

Who represented us, the customers, in this crucial disagreement?

It isn't easy to answer. You might say management, offhand, but management's direct responsibility is to the stockholders. Certainly it isn't the labor union because its concern is restricted to its members. If government steps in, is it the consumers' representative? In the past, federal aids to negotiation have never seemed averse to higher costs for steel's customers.

You'd almost say that the fellows who finance the whole operation — the customers who pay for the use of stockholders' capital, for salaries and wages and benefits, for all the purchases from suppliers — are more or less ignored.

But the customers are represented — by a principle. The customer is represented by competition.

And because this competition is in force only among steel companies and not in the Steelworkers union, the customer must depend upon management as advocate.

U. S. Steel and Bethlehem and Republic and a dozen other steel companies may sign the same kind of labor contract but their managements know that there will come a time when they face us — their customers — as competitors for our business.

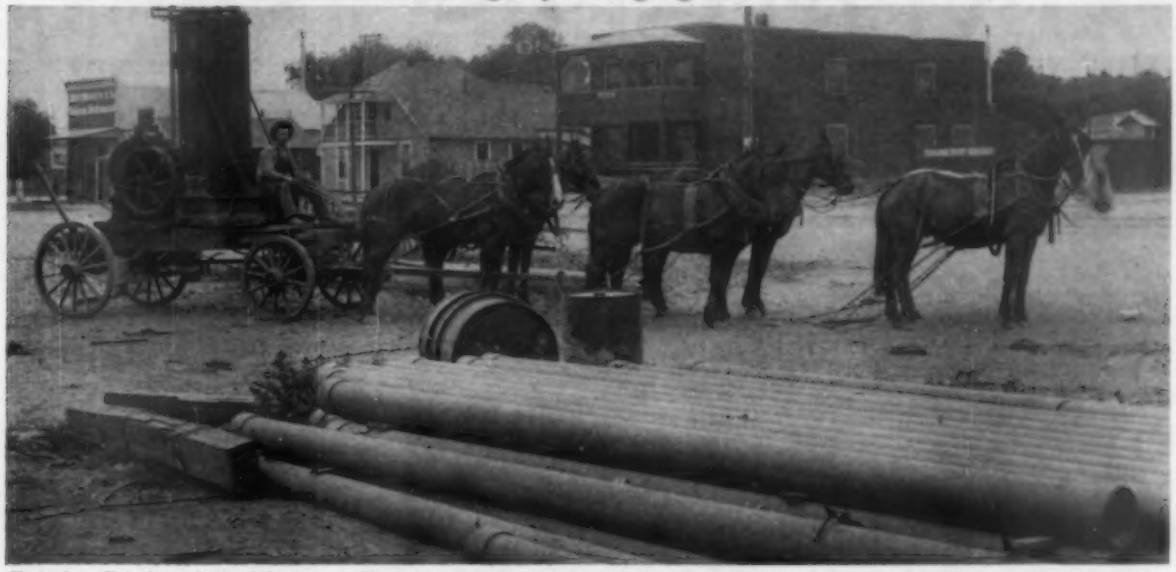
They have to keep wage increases balanced with productivity increase or court inflation and our reluctance to pay higher prices. They need longer contracts for labor peace because they are competing not only with each other but with other industries for our dollars.

Would you as a consumer like a leader to represent you at the bargaining table instead of competition?

If you think that question through, we believe you'll agree — we are best served by the principle of a free economy — competition.

Ernestine Adams

YOUNGSTOWN meets the challenge of changing conditions



Yesterday—Petroleum in its infancy. . . .When horsepower really meant horses. Bad roads, in addition to limited facilities, made transportation of Oil Field equipment a tremendous job.

Today—Growth of the Petroleum Industry has resulted in vastly improved transportation, storage and handling facilities. Powerful trucks and husky trailers make Oil Field equipment available to the most remote locations.

QUALITY YOUNGSTOWN SERVICE

YOUNGSTOWN OIL COUNTRY TUBULAR GOODS

- Casing—Tubing Drill Pipe
- A full line of types, weights and sizes
- Meets all API specifications
- Satisfactory service in every foot

YOUNGSTOWN KEEPS PACE!

Like transportation, Oil Country Tubular Products have also changed. Old-timers with years of experience know that Youngstown produces Oil Country Tubular Goods to meet the demands of changing conditions and toughest requirements. YOUNGSTOWN has also grown with the Petroleum Industry. Off-shore or on-shore, on the plains or in the mountains, no place is too remote to secure the services of your YOUNGSTOWN representative.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steel

General Offices - Youngstown 1, Ohio

District Sales Offices in Principal Cities

ADVERTISERS' INDEX

A

Advance Oil Tool Co. B-136
Aerotec Corporation, The D-46
Affiliated National Hotels E-16
Aldrich Pump Company, The E-52
Allis-Chalmers D-4
Allis-Chalmers, Buda Division B-86
Alten Foundry & Machine Works, Inc. B-97
American Air Filter Company, Inc. D-1
American Bosch E-21
American Iron & Machine Works Co., Inc. B-5
American Petroleum Institute A-9
American Steel & Wire Division E-18-E-19
Ampco Metal, Inc. B-67, B-71, C-43
Armite Laboratories B-140
Atlas Powder Company B-94-B-95
Assembly Products, Inc. E-22
Axelson Manufacturing Co. B-105-B-108

B

B and W Inc. B-148
Baash-Ross Tool Company B-53
Baker Oil Tools, Inc. B-20, B-50-B-51
Baldwin-Lima-Hamilton Corporation C-46
Baroid Division, National Lead Company B-69-B-70
Beaird, J. B., Company, Inc., The E-35-E-36
Bendix Aviation Corporation, Sintilla Division E-39
Berry Division, Oliver Iron & Steel Corporation D-47
Bethlehem Steel Company C-42
Black, Sivalls & Bryson, Inc. B-75
Brakesol, Inc. E-22
Brazos Equipment Rental Company D-14
Brewster Company, Inc., The B-111-B-112
Bucyrus-Erie Company B-149, D-70
Burns Tool Company B-158

C

Cable Engineering B-140
Cabot Shops, Inc. B-39
Cameron Iron Works, Inc. B-62-B-63
Cannon Electric Co. P-128
Cardwell Manufacturing Company B-72-B-73
Caterpillar Tractor Co. A-16, E-23
Cavins Co. B-136
Chapman Valve Mfg. Company, The E-50
Chemical Process Company, The B-84-B-85
Chicago Bridge & Iron Company E-1a
Cinch Pipeline Equipment, Inc. D-48
Cities Service E-48
Clark Bros. Co. E-54
Classified E-55
Cleveland Trencher Company, The D-55
Climax Engine & Pump Mfg. Co. B-154
Columbian Steel Tank Company E-49
Continental Oil Company B-164
Continental Supply Company B-8-B-9, B-15, B-90, B-93
Cooper-Bessemer Corp. B-45, C-15, D-40-D-41
Core Laboratories, Inc. B-139
Crose, M. J., Manufacturing Co., Inc. D-59
Crutcher-Rolfs-Cummings Co. D-2

D

D+B Division B-15, B-90
DeLaval Steam Turbine Company E-1b
DeZurik Shower Company E-34
Diamond Chain Company, Inc. B-55
Dicalite Division, Great Lakes Carbon Corp. C-45
Dowell Inc. Inside Front Cover, A-15
Dresser Industries, Inc. B-2, B-161, E-54, Inside Back Cover
Drilling & Service B-153
Du Pont, E. I. de Nemours & Co., Inc. B-7, B-159, C-25, C-37-C-38, C-40

E

Eastman Oil Well Survey Company B-4
Electric Auto-Lite Company E-34
Electric Machinery Mfg. Co. E-43
EMSCO Manufacturing Co. B-15 ,B-90, B-93
Engineers & Fabricators, Inc. E-38
Ernst Water Column & Gage Co. C-43, C-45
Ethyl Corporation C-4-C-5

F

Federal Telephone & Radio Company D-10
Fish Engineering Corporation E-15
Fisher Governor Company E-41
Floridin Company C-44
Fluid Packed Pump Company B-121-B-122
Fluor Products Company E-1g
Foxboro Company, The E-1h
France Packing Company E-27
Franks, Division of Cabots Shops, Inc. B-1

G

Gardiner-Denver Company B-17
Gaso Pump & Burner Mfg. Co. D-63
General Mills E-44
Gorman-Rupp Company, The E-32
Grant Oil Tool Company B-131-B-132
Great Lakes Carbon Corporation B-77
Guiberson Corporation, The B-13
Gulf Oil Corporation E-46

H

Halliburton Oil Well Cementing Company Back Cover, B-163
Harbison-Fischer Mfg. Co. B-89
Harshaw Cemical Co., The E-1f
Hercules Tool Company B-117
Hill, Hubbell & Company D-7
Houston Contracting Company D-42
Houston Oil Field Material Company, Inc. B-165
Hughes Tool Company B-11-B-12
Hutchison Calculator D-50
Hutchison Manufacturing Co. B-136
Hydril Company B-43

I

Ingalls Shipbuilding Corporation B-148
Ingersoll-Rand D-64-D-65
International Nickel Company, Inc., The C-28

J

Jensen Bros. Mfg. Co., Inc. B-140
Jones & Laughlin Steel Corporation, Supply Division B-166

K

K & G Oil Tool and Service Company, Inc. B-133
Kaiser Steel Corporation D-69
Kobe, Inc. B-76
Koehring Company E-42
Koppers Company, Inc. D-9, D-60

L

Lane-Wells Company Inside Back Cover, B-2
LeBus International Engineers, Ltd. B-157
LeRoi Division of Westinghouse Air Brake Co. E-47
Lone Star Cement Corporation B-37
Lone Star Steel Company D-37
Lufkin Foundry & Machine Company B-155
Lufkin Rule Company, The E-28

Mc

McCullough Tool Company B-147
McEvoy Company B-99

M

M & V Tank Company B-133
Madsen Works C-46
Magnet Cove Barium Corporation B-161
Maloney, F. H., Company D-11
Manzel Division of Houdaille Industries, Inc. E-20
Martin-Decker Corp. B-16
Martin, John N., Manufacturer B-6
Mathey, C. A., Machine Works, Inc. D-54
Minneapolis-Honeywell Regulator Co. D-5
Mission Manufacturing Co. B-100-B-101
Mixing Equipment Co., Inc. D-13
Moore, Lee C., Corporation B-169

N

National Tank Company E-56
National Tube Division E-45
National Supply Company, The B-79-B-82
Nordberg, Mfg. Co. B-59
Nordstrom Valves Front Cover, E-1c
Norris, W. C., Manucafturer, Inc. A-1
Nugent, Wm. W., & Co., Inc. D-61

O

Ohio Injector Company, The E-29
Oil Center Tool Co. B-18-B-19
Oil Metering and Processing Equipment Corp. B-125
Oil Well Supply Division A-7
Orbit Valves B-129
Otis Pressure Control, Inc. B-114-B-115

P

Pacific Pumps, Inc. B-68
Parkersburg Rig & Reel Company B-162
Parsons Company D-56
Patton Manufacturing Company, Inc. E-27
Pelican Supply Co., Inc. D-67
Perforating Guns Atlas Corporation B-170
Petro-Chem Development Co., Inc. E-2
Petroleum Electric Power Association B-14
Pipe Line Anode Corporation D-62
Pipeline Cleaners Co. D-60
Pipe Linings, Inc. E-1e
Price, H. C., Co. D-67

R

Rector Well Equipment Company, Inc. B-156
Reed Roller Bit Company B-56-B-57
Refinery Supply Company C-46
Republic National Bank of Dallas A-13
Ridge Tool Company, The E-27
Rockford Clutch Division Borg-Warner B-96
Roebling's, John A., Sons Corporation E-37
Rollway Bearing Co., Inc. B-102

S

Salt Water Control, Inc. B-125
Schield-Bantam Co. D-66
Schlumberger Well Surveying Corp. B-150-B-151
Shell Oil Company E-51
Shaffer Tool Works B-141
Sherman Products, Inc. E-40
Smitheo Engineering, Inc. D-15
Southwest Industries, Inc. B-135
Spang & Company B-137
Stitt Ignition Company E-22
Sun Shipbuilding & Dry Dock Company C-1

T

Thornhill-Craver Co. B-168
Tretolite Company C-27
Tube Turns E-25-E-26
Twin Disc Clutch Company B-152

U

Union Switch & Signal, Division of Westinghouse Air Brake Company D-68
United States Rubber Company C-31
United States Rubber Company, Naugatuck Chemical Division E-53
United States Steel Corporation A-7, B-143, E-18-E-19, E-45
Universal Atlas Cement Company B-143
Universal Oil Products Co. C-2, C-20-C-21

V

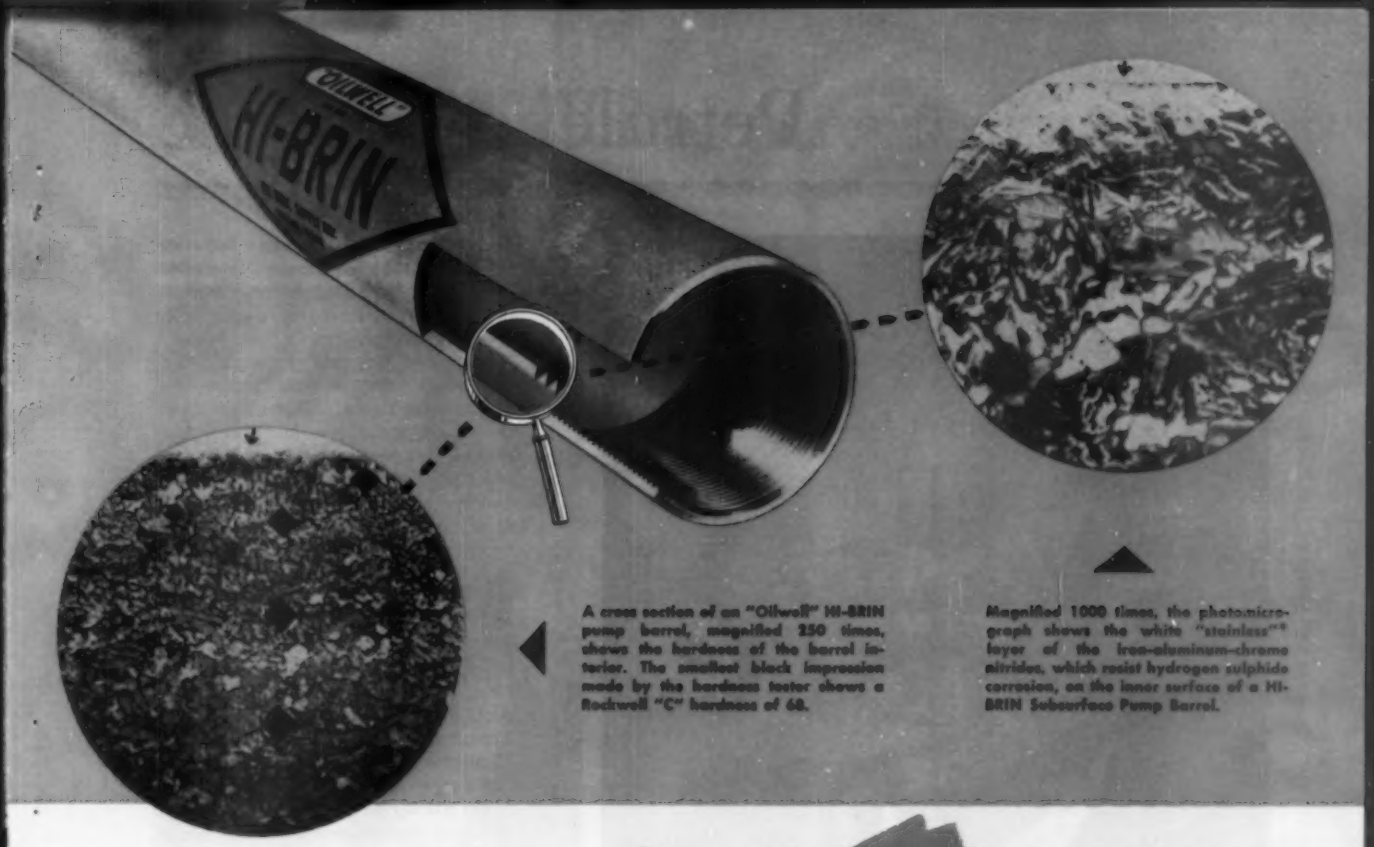
Visco Products Company, Incorporated E-1
Vogt, Henry, Machine Co. C-19

W

W-K-M Manufacturing Company, Inc., a Subsidiary of A C F Industries Inc. D-52
Warner Lewis Company D-36
Waukesha Motor Company B-160
Waukesha Sales & Service, Inc. E-33
Well Equipment Mfg. Corp. B-167
Western Company, The B-126-B-127
Western Gear Corporation D-8
Weston Electrical Instrument Corp. C-35
White Diesel Engine Division E-31
Wickes Boiler Co., The C-32-C-33
Williams Brothers E-30
Williamson, T. D., Inc. D-59
Willis Oil Tool Company B-103
Wilson Manufacturing Co., Inc. B-145
Wilson Supply Co. B-10
Gar Wood Industries, Inc. D-12
Worthington Corporation B-130

Y

Youngstown Sheet & Tube Company, The A-5



A cross section of an "Oilwell" HI-BRIN pump barrel, magnified 250 times, shows the hardness of the barrel interior. The smallest black impression made by the hardness tester shows a Rockwell "C" hardness of 68.

Magnified 1000 times, the photomicrograph shows the white "stainless"* layer of the iron-aluminum-chrome nitrides, which resist hydrogen sulphide corrosion, on the inner surface of a Hi-BRIN Subsurface Pump Barrel.

You can *see* the reason why "Oilwell" Hi-Brin Subsurface Pump Barrels *are so outstanding in their class!*

You do not need the trained eye of the metallurgist to see, in these photomicrographs, why Hi-Brin Barrels have superior resistance to hydrogen sulphide corrosion and abrasive wear.

The white "stainless"* layer in the upper right-hand picture is composed of superhard nitrides which are extremely resistant to hydrogen sulphide corrosion. When produced by "Oilwell's" exclusive (patented) Nitrocycle process, these nitrides penetrate deeper and attain an homogeneous surface that is free from the brittleness peculiar to conventional nitriding processes.

The black, diamond-shaped test impressions in the lower left-hand picture show the uniform inside hardness which makes Hi-Brin Barrels so resistant to abrasive wear. Distortions, associated with conventional surface-hardening methods, are avoided with the controlled Nitrocycle process. As a result, these barrels can be advance finish-honed, with only a light polishing operation after the surface is hardened, removing only 1/10,000 of an inch and leaving all the desirable hardened surface to serve in your well. Bore size and straightness are controlled by precision air-gauging.

**Experience shows excellent resistance to the acid sulphide corrosion found in wells, just as it resists the acid used for etching the micro specimen.*

But pictures alone can't give you ALL the facts about these HI-BRIN Barrels!

STRENGTH . . . is provided by the 3½% nickel steel tube that has its own outside heat treatment for maximum toughness.

ECONOMY . . . results from one-piece barrel construction, even up to the 30-foot lengths.

Contact your "Oilwell" representative or your "Oilwell" store for a HI-BRIN Subsurface Pump. Test it in a hydrogen sulphide well, even under severe abrasion conditions. One HI-BRIN pump always leads to more.

OIL WELL SUPPLY
DIVISION UNITED STATES STEEL CORPORATION

Executive Offices—DALLAS, TEXAS
Export Office—
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.

Area Offices—
CALGARY, ALBERTA
CASPER, WYOMING.....COLUMBUS, O.
DALLAS, TEXAS.....HOUSTON, TEXAS
TULSA, OKLA.....LOS ANGELES, CALIF.

Branches Serving All Oil Fields

USS TRADE MARK

"OILWELL"
TRADE MARK

UNITED STATES STEEL

Petroleum Profile

L. F. McCOLLUM
President
Continental Oil Company

"BUILDER of industry, brilliant captain of men, civic leader and successful geologist, he has risen through the ranks to become head of one of our nation's great petroleum corporations."

This was the tribute paid to L. F. McCollum, president of Continental Oil Company, on May 25, at Golden, Colorado, at the annual commencement exercises of the Colorado School of Mines. Mr. McCollum was the principal speaker at the ceremony and was awarded an honorary doctor of engineering degree.

The honor conferred upon Mr. McCollum by the Colorado School of Mines is another bright milestone in the phenomenal career of this self-made industrial leader.

Born in Tennessee, Leonard Franklin McCollum was raised on a South Texas farm near Cuero. After receiving a degree in geology from the University of Texas, he spent several years as a geologist with Humble Oil and Refining Company and later joined Carter Oil Company, another subsidiary of Jersey Standard.

He was exploration manager, then president of Carter. He later moved east to Jersey Standard and was coordinator of that firm's world-wide production operations when he accepted the presidency of Continental Oil Company in 1947.

With Conoco, Mr. McCollum has implemented a large-scale program of decentralizing the company's operations to meet its needs for future growth. Simultaneously, under his leadership, Conoco has greatly expanded its exploration, production, transportation, manufacturing and marketing operations.

In addition, the Continental president has placed added emphasis on petrochemicals, foreign and offshore operations, organizational planning, and research and development.

A keen student of human behavior and a man who is genuinely interested in people, he also has helped institute liberalized retirement and disability plans for employees; a thrift and "Home and Hospital" medical coverage plans; college scholarships for Conoco employees' children; improved recreation, safety, training and employee communications activities; an expanded public relations program; and company-wide personnel development opportunities.

Mr. McCollum has an incredible capacity for hard work and his activities are numerous and diversified. In addition to being chief executive and a director of Continental Oil Company, he is a director of J. P. Morgan and Company, New York; Chance-Vought Aircraft, Inc., Dallas; The American Petroleum Institute; the Texas-Mid-Continent Oil and Gas Association and other oil industry organizations.

He has served both the API and the National Petroleum Council as chairman of committees on oil and gas availability and is a member of the U. S. Department of Commerce Business Advisory Council. He also holds directorships in seven Conoco affiliates.

In addition, the Conoco president is a trustee of the Institute of International Education; a member of the National Policy Board of the American Assembly, Columbia University; and on the advisory boards of the University of Texas Geology Foundation and the University of Texas' department of petroleum engineering.

Never too busy to follow his own advice that businessmen have an obligation to serve their communities, Mr. McCollum has been a director of the Houston Chamber of Commerce and the United Fund of Houston and is currently a director, trustee or member of: The Methodist Hospital, Houston; Houston Horse Show Association; Houston Committee on Foreign Relations; Houston Geological Society; and the English Speaking Union.

Mr. McCollum is an outstanding symbol of the modern business leader. Keenly atune to the problems of management and employees, he also feels equal responsibility to stockholders, consumers and the community. He is optimistic about the future and feels a free and unfettered industry can achieve still greater things and give the American people an even higher standard of living.

LEADING EDUCATOR WELCOMES OILMEN'S SCHOOL PROGRAM:

Dr. Kenneth E. Oberholtzer, Superintendent, Denver Schools and Past President, American Association of School Administrators.

"The American Petroleum Institute is to be complimented on its school program and encouraged to develop it in new ways. I feel that a greater effort should be made to acquaint more schools with the availability of this material."

Kenneth E. Oberholtzer

Why America's Youth Should Learn the Truth About The Oil Business...

The future of America's free enterprise system is in the hands of today's high school students. That's why it's so important that they understand how this competitive business system works. And, to you, as oil men and women, it is equally important that they discover how this system works to everybody's advantage.

The School Program Tells the Story

Through *The Petroleum School Series* high school students learn far more than *facts* about oil. They learn how *competition* between oil companies and individuals keeps producing new and better oil products to keep boosting America's standard of living up and up.

Here are some of the charts, booklets and films used in The Petroleum School Series.

How You Can Help

Although many schools already use *The Petroleum School Series* there are other schools that still don't know about it. And that's where you come in. By working with the Oil Industry Information Committee in your area, you can provide your local school with School Program materials. When you do you'll not only perform a worthwhile job for your industry, but you'll get that rewarding feeling of personal satisfaction from the knowledge that you're helping educate America's youth.

Call your local OIIC today—or write to...

AMERICAN PETROLEUM INSTITUTE

50 West 50th Street, New York 20, New York

THE CONFERENCE TABLE

"An ounce of enterprise is worth a pound of privilege" — FREDERIC R. MARVIN

A FAIR WAGE

C. W. Anderson*

You cannot fix a "fair wage" . . . It depends on productivity, which depends upon the efficiency of tools . . .

"We must recognize that every employee is entitled to a fair wage." So concluded the speaker, a respected manufacturer and civic leader, elaborating on the development of industrial statesmanship at a typical gathering of American businessmen. Audience reaction indicated approval of this, the voice of "enlightened" management!

While applauding the urge for more statesman-like industrial management, let us examine the implications of this particular declaration: a right to a fair wage.

Suppose, for instance, that a man is employed to produce ordinary aluminum measuring cups. Working with only such hand tools as a hammer and cutting shears, he is able to cut and form two cups an hour — 16 in an 8-hour day; and these hardly the streamlined models which grace a modern kitchen.

A block away, a man using a press, dies, and other mass production equipment turns out high quality aluminum measuring cups at the rate of 320 a day. What is a "fair wage" in each of these plants? Is it the same for the man who forms cups with hand tools as for the man who mass produces them at twenty times the first man's rate?

If the advocate of "fair wages" begins with the assumption that a dollar an hour is a fair wage for the man using hand tools, it is clear that each cup must sell for no less than 50 cents — just to cover labor costs. But charging any such price for handmade cups obviously is out of the question if superior cups from the nearby competing plant are offered, shall we say, at 15 cents each.

If the consumers' choice is to be a determinant of the price of cups, then it appears that this hand craftsman — for the job he is doing — may not be able to earn more than a few cents an hour. Were he to insist on more from his employer, he'd obviously price himself out of that job. This, of course, would leave him the alternative of seeking employment elsewhere; possibly at the highly mechanized plant in the next block.

Within an economy of open competition, it seems reasonable that any person should be free to choose from among various available employment opportunities. But, if all interested parties — including employers and consumers — are to be equally free to choose, then it is clear that the employee may not arbitrarily set his own "fair wage," and demand a job at that rate. Nor can an employer arbitrarily maintain for an appreciable time a "fair wage" that is much higher or lower than is indicated by the competitive situation. If he tries to pay more than is justified by the productivity of his men, he must face bankruptcy. And if he pays much below the prevailing level in that area, his workmen will quit.

If freedom of choice is to be respected, then the only fair wage is one determined by the purely voluntary process of competitive bargaining in a free market.

One may deplore the plight of the poor fellow in the unmechanized plant: how will he use his skills? Indeed, it is unfortunate if he lacks the modern equipment to make his efforts most productive. But to suggest that he should receive more than is reflected in the price consumers will voluntarily pay for cups is to reject the ideal of competitive enterprise, and to accept Marxian philosophy. That would be saying in effect that *need*, and not productivity, determines wages; and that once a person starts work at a certain job, he has a vested interest in that job and a right to receive more than he can earn in it. We may decry the decisions of consumers in the market place if they reject the high-priced product of the hand-skilled employee, but the only substitute arrangement is to deny the consumer's right of choice — by law, forcing him or some other taxpayer to subsidize the particular craftsman.

So a "fair wage" is not something static which anyone can pick out of the air or arbitrarily define. It is not a fixed amount for every employee, but a figure that varies with each person and situation. The physical strength and technical skill of the employee may be highly important factors; but from this simple illustration it is clear that neither these, nor the man's *needs*, can be the sole determinants of wages. The most important single factor is productivity which proceeds from investment in tools. When this truth is recognized, it wholly displaces the fallacious idea of a right to a "fair wage."

Understanding of this economic fact would be an important step in the development of industrial statesmanship. ●

*Anderson is manager of the Employers' Association of Milwaukee, Wisconsin. Article was published in *The Freeman*.

TO HANDLE A PROBLEM

I. Recognize the Problem.

II. Get the Facts
- Review the record
- Find out what policies or customs apply
- Talk with individuals concerned
- Get opinions and feelings
- (Be sure you have the whole story)

III. Weigh the Facts
- Consider their bearing on each other
- Are there any gaps or contradictions?

IV. Determine the Objective
- What do I want to accomplish?

V. Make a Decision
- What possible actions are there?
- Check against practices and policies
- Will it accomplish the objective?
- Consider effect on the individual, the group, and production

VI. Take Action
- Do you need help in handling?
- Watch the timing of your action

VII. Check Results
- Set time for follow-up
- Watch for changes in output, attitudes and relationships

Did your action help Production or Morale?

● **"ANYTHING THROWN forward"** is Greek for problem. There's no question they get thrown at you but not all of them are straight-forward. Dal Belcher (Page E-3) has worked out a formula that will bounce a problem right into a fitted solver if you'll approach it calmly, sincerely, intelligently, logically . . . Hey — if we're all these things, should we have problems? At left is a card with the procedure in short form.

Dollar, Dollar, Who Gets the Dollar?

It was almost 10 years ago that two research-writers from the American Economic Foundation rushed in where angels feared to tread.

After much experimental research into the division of the total income of American corporations, they came up with the following estimate of who got how much of the corporate income after payment of outside costs and taxes:

For the human energy of employees (Wages, salaries and benefits)	80%
For the wearing out of tools used by employees (Depreciation, obsolescence, etc.)	10%
For the use of tools supplied by owners (Profits, dividends, retaining earnings, etc.)	10%

The publication of these figures created quite a stir among both the critics and defenders of our corporate system. But, the two research-writers stood behind their estimates. That was in 1946.

Today, the truth is known, thanks to a new table of figures made available for the first time through the Federal Reserve Board. This study provides the actual corporation figures for a six-year period ending in 1953.

And, after analyzing these government-collected figures, the two economists from the American Economic Foundation can rightly say — "We told you so."

Here's the way the total income, after payment of outside costs and taxes, of all America's corporations was divided during the six-year period.

For the human energy of employees	82%
For the wearing out of the tools used by employees	7%
For the use of the tools supplied by owners	11%

Of that 11 per cent collected for the use of tools, about three-fourths was paid out in dividends and one-fourth retained in the business.

It should be worth mentioning, too, that the tools perform more than 95 per cent of all the work done in American corporations.

Analyzing these figures, you come up with the idea that the reward for supplying the tools is a modest one.

From Cities Service Empire, May, 1956

What Makes a Big Executive?

An analysis of top management personnel by Mabel Newcomer, (The Big Business Executive, Columbia University Press, New York, $4) is concerned with the factors that made chief executives of big business in the period 1900-1950.

The Vassar College economics professor attempts by survey to find how top men reached the top; what importance family background played; what training and experience they had.

The author discusses the changes in management since 1900 and develops the question of whether present organization could lead to self-perpetuating management.

The statistics are interesting—specially if you are an executive and want to see where you fit. For instance, you are likely to be native born, an Episcopalian, a Republican, and have one college degree.

In qualifications for top executives, Professor Newcomer's authorities go along generally with the view that ability in human relations is most important.

An Orchestra

To achieve its ends, management is somewhat in the position of a conductor who leads a large, enormously complicated symphony. Among the instruments in the industrial orchestra are sales, engineering and production; research, accounting and purchasing; general development, legal work and patent work; and industrial relations, financial relations, and public relations.

*These, and many more, must be meshed into one harmonious whole — although they often seem to play conflicting tunes. * * * All these instruments must be kept in proper tune if the industrial orchestra is even to function.*

...R. Lindley Murray, Board Chairman
Hooker Electrochemical Company,
Accepting 1956 Chemical Industry Medal

Security of Self. *The only security any person can have lies within himself.* Unless he is free to act as an individual, free to be productive in his own behalf, free to determine what part of that production he will consume now and what part he will save, and free to protect his savings, there is no chance that he can find security anywhere.

PAUL L. POIROT—*The Pension Idea.*

Technology Ups the Boom

The most fabulous economic fact of contemporary history is that today's American worker labors 15 per cent fewer hours for double the buying power he had 20 years ago.

The basis for this remarkable fact is the rise of technology. Once dependent entirely upon the inventive genius working alone in his garage, technology has blossomed into an operation employing millions of workers and involving billions of dollars.

Organized industrial research is both behind this upward trend of technology and a result of it. Largely because of research, the national income has risen from less than $100 billion to more than $350 billion in the past 20 years.†

The Rhamphorhynchus* Situation

There is a company in Jamacia, New York that sells miniature prehistoric animals. Because we enjoy the sales letters, we hope they sell enough to keep sending more. Here is part of the last one:

You can't be happy if you don't got a Rhamphorhynchus and your chances of having a Rhamphorhynchus are mighty slim as we here at the Abbeon Dinosaur Works darn near got a corner on the Rhamphorhynchus market.

Did you ever stop to realize that no home or office is complete without a Rhamphorhynchus? Luckily this sad Ramphorhynchusless situation of yours can be easily remedied. Just send your latest alias and your current (Rent Paid) address, $2.00 and your Prehistoric Pterosauria will be sent to you posthaste.

---

†From *Frontier*, published by Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago, Illinois.

*Rhamphorhynchus is pronounced — Ram-fo-rink-us.

HIGHLIGHTS

★ ★ ★

Digest of News and Comment

Merger is the answer to the economic problems of the small oil producing companies, says R. G. Greene, president of Great Basins Petroleum Company, Denver, Colorado. Combination of such companies, on a stock trade basis, would combine assets of the merged firms so that it could be efficiently developed at sharply slashed operational costs, Greene says. Great Basins recently acquired all assets of Lincoln Petroleum Company, Los Angeles, California, Brown Well Service of West Texas, Odessa, and Lincoln Oil, Gas & Refining Company, Denver, Colorado.

★ ★ ★

WANTED: Engineering instructors. Engineering colleges in the U. S. need 1300 more teachers to carry the coming 1956-57 academic load, reported an industry committee of the American Society for Engineering in Education. Engineering colleges have experienced a net loss of three per cent of their professors to industry within a two-year period. Most of the 750 instructors that have left the engineering faculties to enter private industry have gone for higher salaries, the ASEE reports.

★ ★ ★

No natural gas legislation until next year, producers have been told. Eisenhower administration leaders have assured independent gas producers that an FPC decontrol bill was on the docket for 1957, however. Type of legislation sought for will depend on that agreed upon by those within the industry — which at present is not so clear. A recent meeting in Houston, Texas, broke up with different factions — the pipe lines, producers and distributors — each taking a very different view of the needs of such a law.

★ ★ ★

Four U. S. oil companies have entered into a joint venture involving about 28,000 acres of new oil concessions in Lake Maracaibo, Venezuela. The companies sharing in the new lease agreement are Hancock Oil, Pure Oil, Signal Oil and Gas, and Standard Oil (Ohio). Each has an equal interest in the concession.

★ ★ ★

Direct gasoline sales taxes now average about 40 per cent of the retail price paid by motorists. This represents the highest levy in the nation on any essential commodity. D. F. Benton, vice president of Standard of Indiana, in a recent statement pointed out that the combined national average state and federal taxes have now climbed to 8.8 cents on every gallon of gasoline. The average motorist, Benton figures, who uses about 750 gallons of gas a year, pays about $66 a year in taxes for it.

★ ★ ★

Construction of a new steel mill near Houston, Texas, as proposed by Jones & Laughlin, depends on whether or not the government would grant a fast tax write-off. The plant, if built, would turn out about 1,000,000 net tons of steel ingot in the form of seamless pipe and tubing. Construction of the new plant would move the production center of seamless pipe considerably westward — an aid to the steel-hungry oil industry. At present, about 80 per cent of the nation's pipe of this type is made in Pennsylvania and Ohio.

★ ★ ★

"Not essential" is still the word for a proposed crude oil pipe line from West Texas to the West Coast, reiterates Defense Mobilizer Arthur S. Flemming. Recently testifying before a House armed services subcommittee, Flemming said that "nothing has transpired during the past year to change our view of the West Coast pipe line . . . and we would not be justified in authorizing the use of government funds for its financing." In case of war, he assured the subcommittee, supply to that area would be more than adequate, suggesting that Southern Pacific's new products line from El Paso to Los Angeles could be converted to haul Texas crude.

★ ★ ★

The Texas Company's negotiations for the purchase of Trinidad Oil Company, Ltd., are continuing on schedule and "without a hitch," company officials have stated, denying reports that there has been a snag in discussions. In July the British government refused Laborite demands in Parliament for a sale condition that any Trinidad oil shipped to Great Britain should be carried in British tankers. Texaco personnel and officials have spent several weeks conducting surveys of reserves and assets held by Trinidad Oil.

New control laboratory for Ohio Oil Company at Robinson, Illinois, is now under construction. The modern and functionally-designed lab will completely replace an older one, and will include new instruments and apparatus to improve and check the operating efficiency of the company's processing units there.

★ ★ ★

"Inferior" use of natural gas as boiler fuel looms as a major controversy in Washington in coming months. Coal and labor groups continue to voice disapproval of FPC's recent reversal of its stand against inferior gas use in the "Black Dog" Case involving Northern Natural Gas Company, Omaha, Nebraska. The commission's recent "change of heart" favoring gas interests, was given grudgingly, suggesting that boiler fuel use be permitted only when positively required by public convenience and necessity.

★ ★ ★

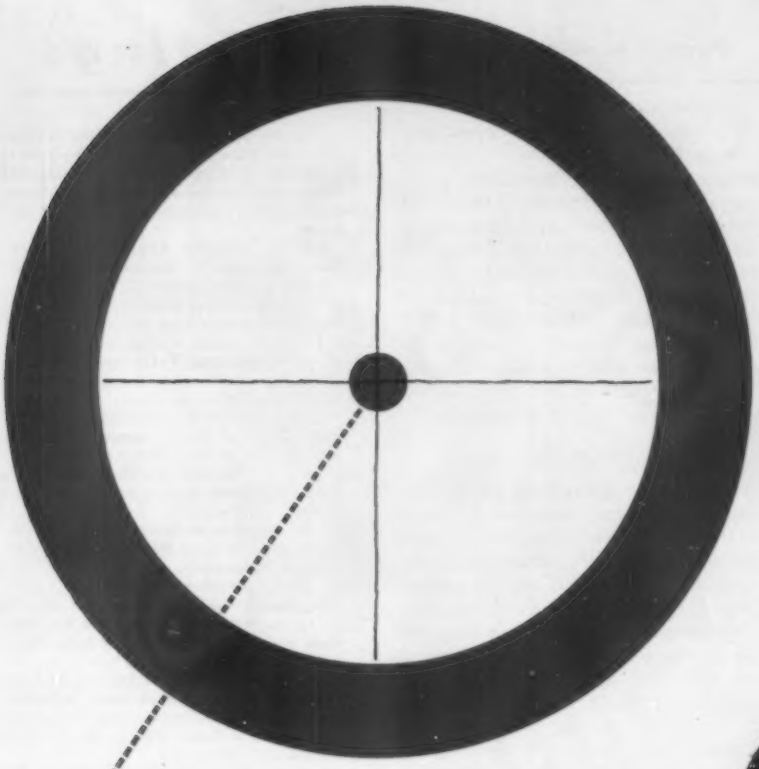
Total employment in the U. S. reached a new peak in the month of June. For the first time in history more than 66,500,000 were gainfully employed, reflecting an increase of 2,500,000 above the same period in 1955. Factory jobs, according to a recent report, are less numerous than in the peak year of 1953, although other non-agricultural jobs have increased by more than 2,000,000.

★ ★ ★

Construction of British Petroleum Company's $4,000,000 research station, near London, is now under way. Central unit of the expansion plan is a new analytical and physics laboratory, employing about 300 technicians. Research station staff will be about 1400 in the completed project. The entire project is scheduled for 1958 completion.

★ ★ ★

Banquet speaker for the fifth annual convention of the Association of Desk and Derrick Clubs of North America is to be H. S. M. Burns, president of Shell Oil Company. Some 1500 members will convene in New Orleans, Louisiana, September 7-8, with representatives from the 111 chapters in the U. S. and Canada. Mrs. Sybil Sureck, 1955 association president, will be the keynote speaker. Miss Edna Hurry, Jersey Standard, is 1956 president.



Looking for

OIL

financing?

Look to the **LEADER**

REPUBLIC NATIONAL BANK OF DALLAS

Take the shortest distance to a solution to your production financing problem.

Take it to the Republic National Bank of Dallas . . . pioneer "Oil Bank" of the Southwest.

At Republic, you'll find the Southwest's largest and most active Oil Department . . . men whose first and most important question is always . . .

WHAT CAN *WE* DO FOR *YOU*?

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

REPUBLIC National BANK of Dallas

CAPITAL AND SURPLUS $70,000,000 ★ LARGEST IN THE SOUTH

World oil consumption in the first six months of 1956 is 10 per cent above that of last year, The Financial Times, London, England, reports. The increase was due largely an "unexpected" rise in U. S. and Western European consumption. The Times had anticipated only a 4 per cent increase over last year; last year's consumption rise in this country was 8 per cent.

★ ★ ★

Federal laws to hold imports at 1954 levels are predicted to pass the next session of congress, says Representative Vursell of Illinois. Vursell, a strong advocate of the 27½ per cent depletion allowance and a tight imports policy, praised Mobilization Director Arthur S. Flemming and congress for making every effort to get major importing companies voluntarily to reduce oil imports and "comply with the expressed will of the congress and the executive department."

★ ★ ★

Oil field thefts in Texas have attracted particular attention of state law enforcement officers. Oil operators have been asked to take every precaution against such thievery that usually breaks out during periods of equipment shortage. George Robey, chief special investigator, Texas Mid-Continent Oil & Gas Association, who recently distributed a special bulletin to state law officers, asked for aid in preventing the formation of organized looting operations. A $100 reward has been posted "for information and help in conviction of oil field thieves."

★ ★ ★

Law library valued at $35,000 has been donated to the University of Oklahoma law school by Sunray Mid-Continent Oil Company and its subsidiariary, D-X Sunray Oil Company, of Tulsa, Oklahoma. The gift, consisting of some 4500 volumes, represents basically the law library of the former Mid-Continent Petroleum Corporation that merged into Sunray Oil Corporation last year.

★ ★ ★

Military Petroleum Advisory Board members have been reappointed by Secretary of the Interior Fred A. Seaton to serve for another three years. The board's eight members provide the Departments of the Interior and Defense and the Office of Defense Mobilization with advice and information on oil and gas matters relating to national security and defense.

Texas independent oilmen are putting final touches on a proposed program for solving the industry's foreign oil imports problem. Confidential reports have been circulated among members of the executive committee of the Texas Independent Producers and Royalty Owners Association in efforts to bring a master plan before its August meeting. The plan would then be presented to government officials. It is expected that TIRPO will seek IPAA backing for the program.

★ ★ ★

Farmers' gasoline price increase will be the subject of a special hearing by the House agriculture committee. The sessions, presumably to be held in Texas, would take testimony from "higher-up" officials of major oil companies, says Congressman Poage of Texas, who brought the complaints to the attention of the committee. The complaint stems from a ½-cent increase in tank wagon prices to Texas farmers and ranchers. Oil company leaders say the farmers were buying gasoline at prices less than those paid by service stations.

★ ★ ★

Bought . . . Sold . . . Merged: *British American Oil Company* has completed its acquisition of *Canadian Gulf Oil Company*. All business of the latter company is now being conducted under the British American name. Merger result is that assets of B-A are doubled, its oil reserves quadrupled and on completion of a pipe line now under construction, B-A will be Canada's largest producer of natural gas . . . *City Products Corporation of Chicago* has acquired all capital stock of *Premier Oil Refining Company of Texas*, with general offices in Longview. Premier operates refineries at Longview, Fort Worth and Baird, Texas, and under the new set-up will continue to market Premier gasoline in Texas and its refined products will still be shipped to Southwest markets . . . *John W. Mecom*, Houston independent oil operator has purchased for $15,000,000 cash, about 275,000 acres of producing and non-producing oil properties of the *San Jacinto Petroleum Corporation* and *Waterford Oil Company of New Orleans*. The properties are all located in Louisiana . . . Acquisition of *Anderson-Prichard Oil Corporation* by *Phillips Petroleum Company* is current Wall Street rumor. Roland Rodman, president of the Oklahoma City-based Apco, won't deny or confirm the rumor.

Meetings

Aug. 16—**API OIIC Steering Committee,** API Board Room, New York City, New York.

Aug. 20-Sept. 7—**Short Course in Colloidal Phenomena in the Petroleum Sciences,** Louisiana State University, Baton Rouge, Louisiana.

Aug. 23-25—**Alberta Society of Petroleum Geologists,** 6th annual field conference, Calgary, Alberta, Canada.

Sept. 5-7—**Wyoming Geological Association,** 11th annual field conference, Jackson Lake Lodge, Moran, Wyoming.

Sept. 6-7—**American Petroleum Institute,** Oil Industry Information Committee, Conrad Hilton Hotel, Chicago, Illinois.

Sept. 7-8—**Association of Desk and Derrick Clubs of North America,** 5th annual convention, New Orleans, Louisiana.

Sept. 9-12—**American Institute of Chemical Engineers,** William Penn Hotel, Pittsburgh, Pennsylvania.

Sept. 10-14—**International Congress on Catalysis,** Bellevue-Stratford Hotel, Philadelphia, Pennsylvania.

Sept. 11-13—**Pacific Coast Gas Association,** annual meeting, Coronado, California.

Sept. 12-14—**National Petroleum Association,** annual meeting, Traymore Hotel, Atlantic City, New Jersey.

Sept. 12-14. **Third Annual Electrical Conference of the Petroleum Industry,** sponsored by American Institute of Electrical Engineers and Kansas City Section of AIEE, Kansas City, Missouri.

Sept. 16-18—**Pennsylvania Petroleum Association,** annual meeting, Pocono Manor Inn, Pocono Manor, Pennsylvania.

Sept. 16-18—**New Mexico Petroleum Industries Committee,** annual meeting, Hilton Hotel, Albuquerque, New Mexico.

Sept. 16-21—**American Chemical Society,** 130th annual meeting, Atlantic City, New Jersey.

Sept. 16-22—**American Society for Testing Materials,** Pacific Coast meeting, Hotel Statler, Los Angeles, California.

Sept. 17-21—**Instrument Society of America,** annual, Instrument-Automation Conference and Exhibit (International), New York Coliseum, New York City.

Sept. 20-21—**Mid-Continent Oil and Gas Association,** La.-Ark. division membership meeting, Roosevelt Hotel, New Orleans, Louisiana.

Sept. 20-21—**Western Petroleum Refiners Association,** regional technical-industrial relations meeting, Hotel Henning, Casper, Wyoming.

Sept. 23-26—**American Society of Mechanical Engineers,** 1956 petroleum mechanical engineering conference, Statler Hilton Hotel, Dallas, Texas.

Sept. 26—**American Petroleum Institute,** Executive Committee of the Board of Directors, Greenbrier Hotel, White Sulphur Springs, West Virginia.

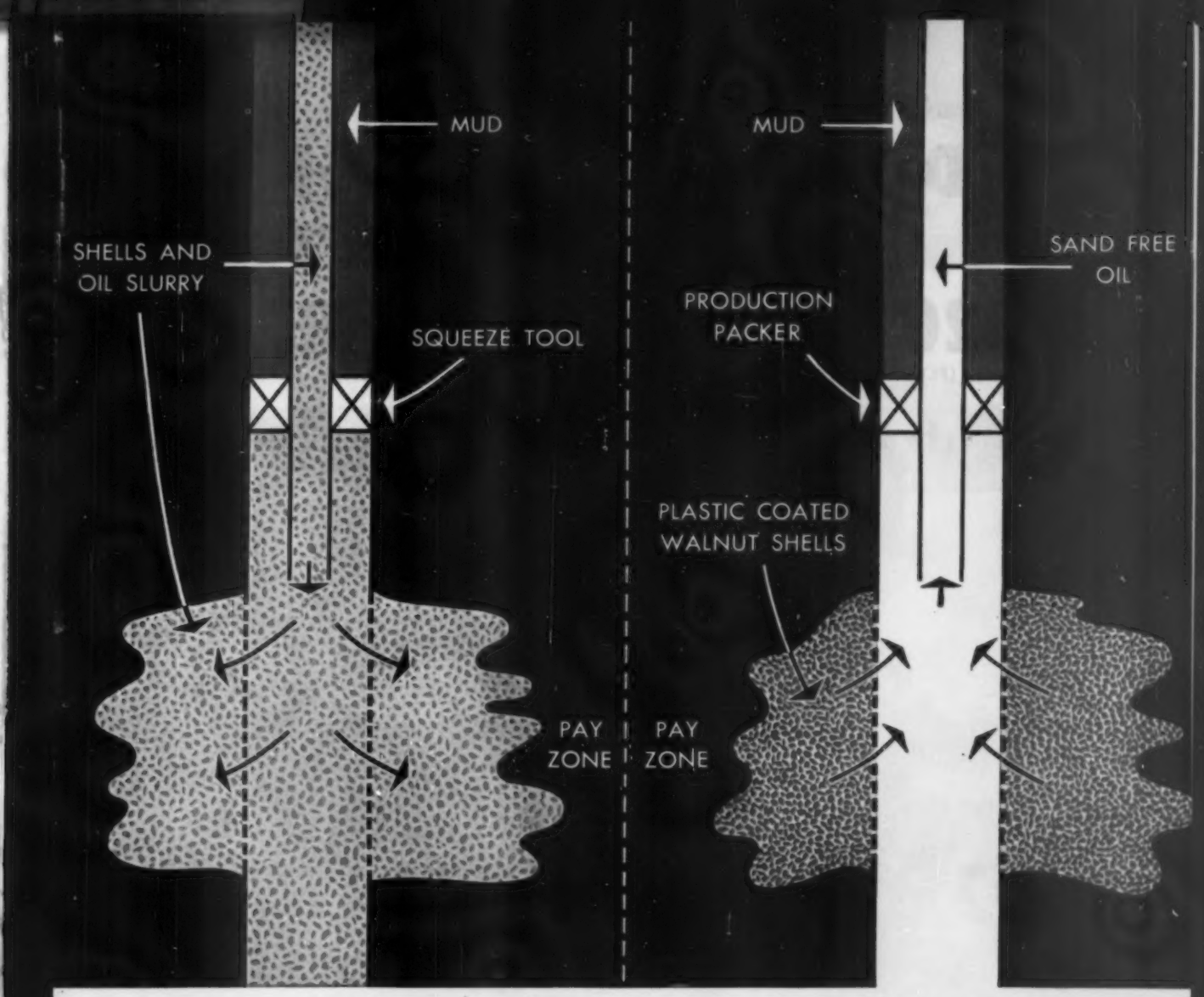
Sept. 26-28—**American Institute of Mining, Metallurgical & Petroleum Engineers,** Rocky Mountain mineral conference, Newhouse Hotel, Salt Lake City.

Oct. 1-5—**American Institute of Electrical Engineers,** Morrison Hotel, Chicago, Illinois.

Oct. 2-3—**Texas Mid-Continent Oil & Gas Association,** 37th annual meeting, Rice Hotel, Houston, Texas.

Oct. 2-4—**National Association of Corrosion Engineers,** South central region, Beaumont, Texas.

Oct. 7-9—**American Association of Oilwell Drilling Contractors,** 16th annual meeting, Texas Hotel, Fort Worth, Texas.



1. ***Plastic coated walnut shells*** **in oil are injected under pressure into loose sand formation.**

2. **When plastic sets, the shells form a rigid wall, through which sand-free oil can be produced.**

NEW CONTROL METHOD STOPS LOOSE SAND

Sandlock*, the newest method for blocking unconsolidated sands, employs walnut shells and plastic to form a tough, permeable wall.

Crushed and graded walnut shells are coated with liquid, unset plastic. The shells are then blended with a carrying fluid and pumped into position in the well. Upon hardening, a rigid wall of shells is formed to hold back the loose sand. The compressive strength of the wall varies from 1500 to 2000 p.s.i., while the permeability ranges up to several hundred darcys.

Even though Sandlock service has had great success since its introduction, Dowell has continued to make improvements. These are just a few: (1) a new acid flash-setting technique—cuts downtime considerably; (2) jelled diesel oil can now be used as the carrying fluid—returns to well bore faster; (3) no permanent liners are needed—eliminates costly fishing; (4) walnut shells are pushed back into formation for freer oil flow—provides larger drainage area.

For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell, Incorporated, Tulsa 1, Oklahoma, Department H-12.

*Service Mark of Dowell Incorporated

services for the oil industry **DOWELL**

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

To celebrate its first birthday

THE D9 GETS INCREASED HP

—more power for your operation!

320 HP
(FLYWHEEL)

formerly 286 HP

260 HP
(DRAWBAR)

formerly 230 HP

The giant Turbocharged CAT* D9 Tractor, which since its introduction last year has set new performance standards in the field, now packs more power than ever to handle even bigger jobs. Its drawbar capacity has been increased from 230 HP to 260 HP—its flywheel horsepower from 286 to 320!

This increase in power reflects Caterpillar's policy of leadership in action. Combining research with practical field experience, there's constant product improvement to meet your needs for bigger production at lower cost. This policy applies to *every* product in the Caterpillar line—Diesel Engines, Tractors, Motor Graders and Earthmoving Equipment.

Now, with its increased horsepower, you can give the D9 tougher jobs than ever before. To match your requirements, it's available with torque converter or direct drive with oil clutch. For complete details about the more powerful D9, see your Caterpillar Dealer. Name the date—he'll be glad to demonstrate!

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

D9—MORE POWERFUL FOR BIGGER PRODUCTION

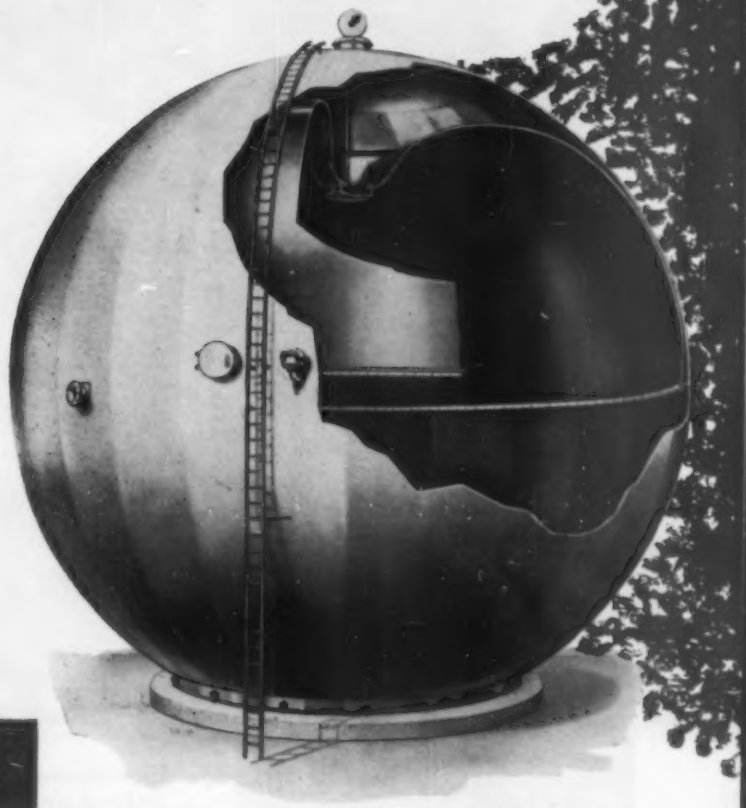
Vapor Conservation...

and the HORTON Vaporsphere

A Horton Vaporsphere®, used as the central storage unit for a vapor conservation system, provides a flexible system from which the Vaporsphere can be isolated to accommodate product changes in the interconnected tanks.

Operation of the Vaporsphere is simple. Vapor, displaced from interconnected fixed-roof tanks, is stored under a flexible hemispherical membrane inside the Vaporsphere. When conditions causing vapor displacement are reversed, the vapor returns to the tanks.

We will be happy to provide further information, estimates or quotations on Horton Vaporspheres, or other Horton vapor conservation systems. Write our nearest office today.



Above: Cutaway view of Horton Vaporsphere showing the flexible hemispherical membrane. As vapor is displaced from interconnected tanks, the membrane rises to provide room for it.

Left: 150,000-cu. ft. Horton Vaporsphere, one of two at Shell Oil Company's Dominguez, California refinery.

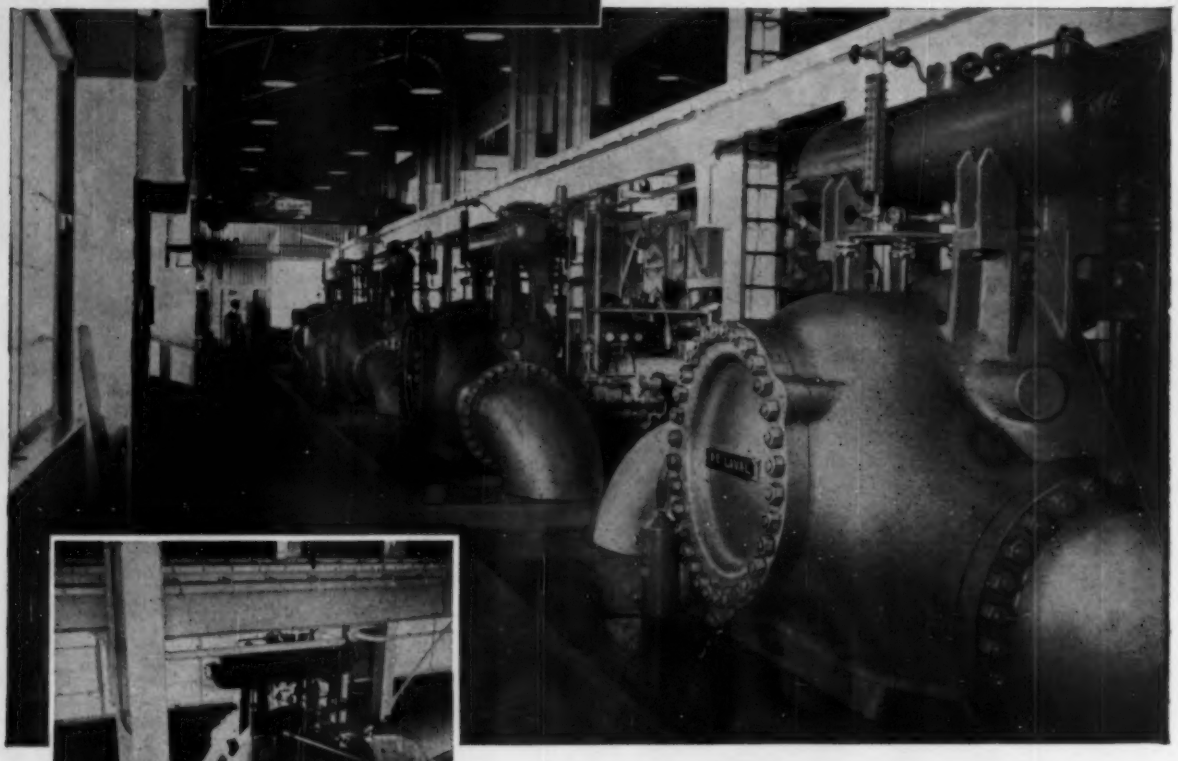
CBI

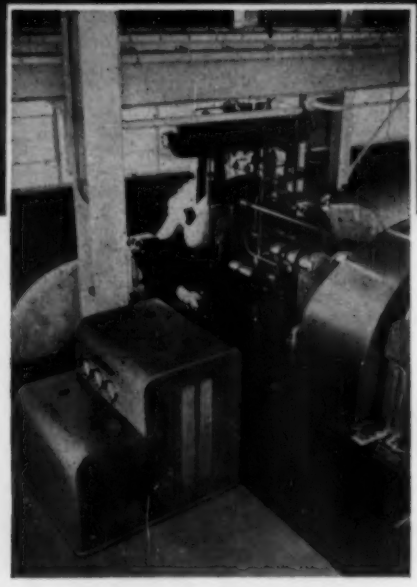
Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
New York • Philadelphia • Pittsburgh • Salt Lake City • San Francisco
Seattle • South Pasadena • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

REPRESENTATIVES AND LICENSEES:
Brazil • Canada • England • France • Italy • Netherlands • Scotland • Venezuela

FOUR DE LAVAL CENTRIFUGAL COMPRESSORS *in Tescott, Kansas station of Northern Natural Gas*





For easy installation, De Laval pipeline compressors are designed in two packages: (1) The machine plus the emergency seal tank, (2) The auxiliary console which contains the filters, pumps, coolers and other accessories.

Here's more proof of the efficiency and dependability of De Laval centrifugal compressors for high pressure gas transmission. This Tescott, Kansas station of the Northern Natural Gas Co. has four De Laval centrifugal compressors in series.

The station flow is 930 M²SCFD, station inlet pressure 477 psig and discharge pressure 745 psig. *By changing the impeller and a few minor parts, these units can handle 1,100 to 1,200 M²SCFD.* Three identical De Laval compressors are on the job in the Macksville, Kansas station of Northern Natural.

De Laval centrifugal compressors offer important engineering features. • Pressure contact shaft seal eliminates gas leakage. • Construction is heavy and rigid throughout. • Units have high load carrying capacity. De Laval units, totaling more than 280,000 hp, are now in operation on major pipelines.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
869 Nottingham Way, Trenton 2, New Jersey

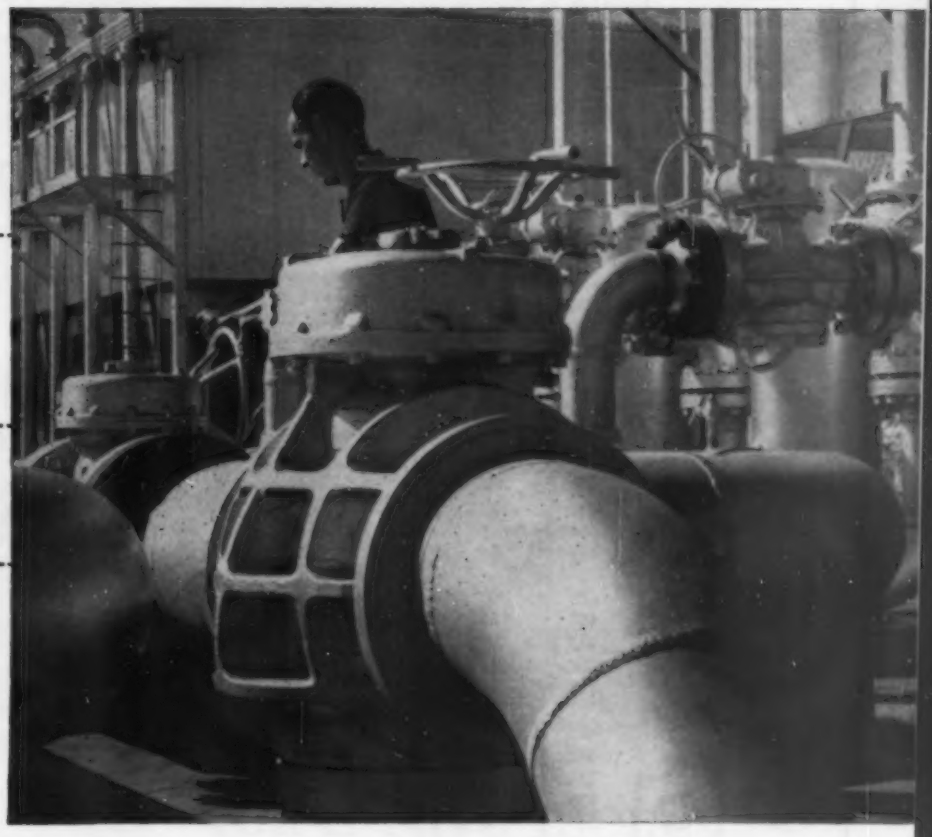
DLS09

Positive Shut-Off

Fast, Smooth Closure

Low Maintenance

Rockwell-Nordstrom Valves



For forty years, field experience has proven that you can't buy a better valve than Rockwell-Nordstrom. Pressurized lubricant sealing assures positive shut-off because the seal doesn't depend upon uncertain metal-to-metal closure. The *tapered* plug seats perfectly, and can be hydraulically jacked for *instant* operation. And facts and figures in hundreds of refineries, gasoline plants and petrochemical plants prove that lubrication saves money by cutting repair, replacement and down time costs.

Wrench and gear operation is fast and smooth with Nordstroms because the plug requires only a quarter-turn for closure and it glides on the lubricant film. Their speed and ease of operation make them ideal for automation or remote power operation, too.

Rockwell-Nordstrom is *the original and only complete line* of lubricated plug valves. There is a size, pressure-temperature rating and pattern to fit your needs. Write for more information today: Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Valve Licensee: Peacock Brothers Limited.*

ROCKWELL-Nordstrom VALVES

Lubricant Sealed for Positive Shut-Off
40th YEAR *of lubricated plug valve leadership*

24-HOUR CAPACITY* OF 4-IN. BY 1¼-IN. ORIFICE PLATE—FLANGE CONNECTIONS

Pressure, lb. per sq. in. ga.	Differential, in. of water										
	5	10	20	30	40	50	60	70	80	90	100
10	110	156	220	270	312	348	382	412	441	467	493
20	131	185	262	320	370	414	453	489	523	555	585
30	149	210	297	364	420	470	515	556	594	630	664
40	164	233	329	403	465	520	570	615	658	698	736
50	179	253	358	438	506	566	620	670	716	759	800
60	192	272	385	471	544	608	666	720	769	816	860
70	205	290	410	502	579	648	710	766	819	869	916
80	217	306	433	531	613	685	750	811	867	919	969
90	228	322	456	558	644	720	789	853	911	967	1019
100	239	337	477	584	675	754	826	892	954	1012	1067
110	249	352	497	609	703	786	861	931	995	1055	1112
120	258	366	517	633	731	818	895	967	1034	1097	1156
130	268	379	536	656	758	847	928	1002	1072	1137	1199
140	277	392	554	679	784	876	960	1037	1108	1176	1240
150	286	404	572	700	809	904	990	1070	1144	1213	1278
160	294	416	589	721	833	931	1020	1102	1178	1249	1317
170	303	428	606	742	856	958	1049	1133	1212	1284	1354
180	311	440	622	762	879	983	1077	1164	1244	1319	1390
190	319	451	637	781	901	1008	1104	1193	1275	1352	1426
200	326	462	65	800	924	1032	1131	1222	1306	1385	1460
210	334	472	668	818	945	1056	1157	1249	1336	1417	1494
220	341	483	683	836	966	1080	1183	1277	1365	1448	1527
230	349	493	697	854	986	1102	1208	1304	1394	1479	1559
240	356	503	711	871	1006	1125	1232	1330	1423	1509	1591
250	363	513	725	889	1025	1147	1256	1356	1450	1539	1621
260	369	523	739	904	1045	1168	1279	1382	1478	1567	1652
270	376	532	752	921	1064	1189	1302	1407	1504	1596	1681
280	383	541	765	937	1082	1210	1325	1432	1531	1623	1711
290	389	550	778	953	1099	1231	1347	1456	1557	1650	1740
300	396	559	791	968	1118	1250	1369	1480	1582	1677	1768
310	402	568	804	984	1136	1270	1391	1503	1606	1704	1796
320	408	576	816	999	1154	1289	1412	1526	1631	1731	1824
330	414	585	828	1013	1171	1308	1433	1549	1655	1756	1851
340	420	593	840	1028	1188	1327	1454	1571	1679	1781	1878
350	426	602	852	1045	1204	1346	1475	1593	1702	1806	1904
360	432	610	863	1057	1221	1364	1495	1614	1726	1831	1930
370	437	618	875	1071	1237	1382	1515	1635	1749	1855	1956
380	443	626	886	1085	1252	1400	1534	1657	1771	1879	1980
390	449	634	896	1098	1268	1418	1554	1677	1794	1903	2005
400	454	642	907	1112	1283	1435	1573	1698	1816	1926	2030
410	460	650	918	1125	1299	1453	1592	1719	1838	1949	2054
420	465	657	929	1139	1314	1470	1610	1739	1859	1971	2078
430	470	665	940	1152	1329	1487	1629	1759	1881	1994	2102
440	476	672	950	1165	1344	1504	1647	1778	1902	2016	2126
450	481	680	961	1177	1359	1520	1664	1798	1922	2038	2149
460	486	687	971	1190	1374	1536	1682	1817	1943	2060	2172
470	491	694	981	1202	1388	1552	1700	1836	1963	2082	2195
480	496	701	991	1215	1402	1568	1717	1855	1981	2103	2218
490	501	708	1001	1227	1416	1584	1735	1874	2003	2125	2240
500	506	715	1011	1239	1430	1600	1752	1893	2023	2146	2262

4-in. x 1¼-in. orifice plate size, flange connection.
*Million cu. ft. based on (4 ozs.) 14.4 lbs. per sq. in., 0.60 gravity, and 60°F. temperature.

1 hour coefficient = 415.5
24 hour coefficient = 9972.0

Where leakage cannot be tolerated...

Soils of resistivities under about 2,000 ohm-cm, or soils of widely varying resistivities averaging even 5,000 ohm-cm or more, are usually quite corrosive. For such soils Somastic® Pipe Coating is the ideal solution. To avoid the expense of frequent changes in pipe treating equipment and crews on long lines, Somastic Pipe Coating should be used in sections of perhaps five to ten miles minimum length through such soils, even though intermediate stretches were of higher resistivity.

Wherever pipe lines traverse city streets and subdivisions or valuable agricultural property, or lands that may soon be converted to such use, Somastic Pipe Coating is recommended. This added precaution is a good investment against the cost and public ill will that would result from a leak, even though soil studies may not indicate that severe corrosion should be anticipated. A further factor in such locations is that supplementary cathodic protection may not be feasible on poor coating because of the difficulty of obtaining suitable anode locations.

Somastic Pipe Coating has long been the standard for swamp construction, river and harbor crossings, and coated submarine lines. Experience indicates that submarine lines and river crossings can be installed when Somastic Pipe Coating is used without the expensive handling precautions normally required for other coatings. Examples of such use can be supplied including submarine lines in the Persian Gulf, in Lake Maracaibo and in the Pacific.

Although Somastic Pipe Coating can be damaged by unusually rough handling, it is true that it can be installed with a minimum of damage under conditions of mountainous terrain where prewrapped coatings would be damaged in handling and where over-the-trench machines cannot satisfactorily negotiate. Somastic Pipe Coating is usually the best choice when such construction problems are encountered.

Pipe lines are occasionally run through watersheds or river valleys where it is essential that every precaution be taken to prevent leaks. Such locations are an excellent application of Somastic Pipe Coating both because of the protection the coating affords and the evidence given to public authorities and others that the best possible pipe protection is being used.

you'll save money with SOMASTIC® coated pipe lines

SOMASTIC PIPE COATING is available in a number of formulations. Each is an asphalt-mastic designed for continuous, uniform, seamless, impermeable protection.

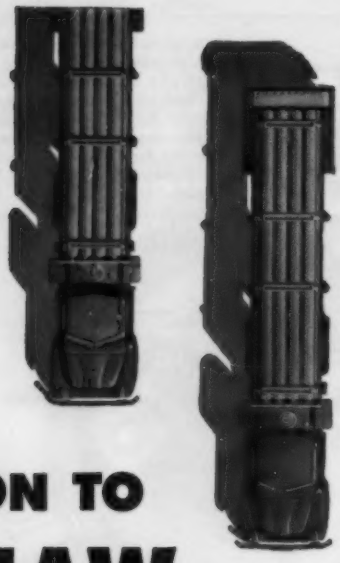
SOMASTIC PIPE COATING is *thick*. There are fewer pits under thick coatings. It is *seamless*. There are no holidays because of overlapping layers or bubbles. It is *reinforced*. The reinforcement is permanent and uniform. It is *rigid yet elastic* . . . withstands depression over long periods, absorbs pipe movement and changes in pipe line temperature. *Proved* under adverse soil conditions for more than 24 years. *That's why Somastic Pipe Coating will save you money wherever leakage cannot be tolerated!*

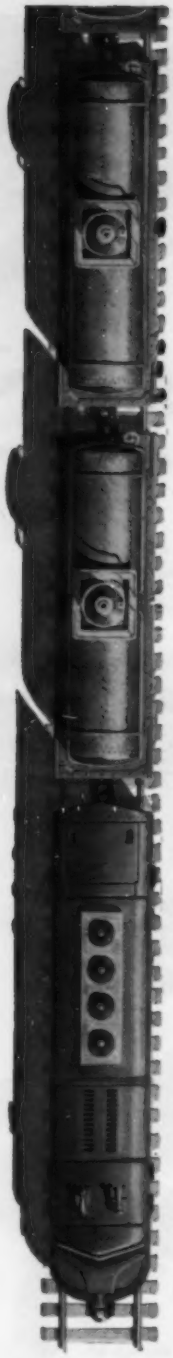
PIPE LININGS, Inc.

Specializing in Pipe Protection Problems · Interior Cement Mortar Lining · Somastic® Exterior Pipe Protection · Pipe Wrapping · Centrifugal Spinning of Cement Mortar Linings In Plant · Pipe Reclamation

Write for full information... **today!**

2414 East 223rd St., Wilmington, California
P. O. Box 457, Wilmington, California
Phone NEvada 6-1771 · Rail Address: Watson, California





IN ADDITION TO HARSHAW

BORON TRIFLUORIDE
HYDROFLUORIC ACID
anhydrous . . . aqueous

Here are many more production-controlled, high-quality fluorides:

- Ammonium Bifluoride
- Ammonium Fluoborate
- Antimony Trifluoride Sublimed
- Barium Fluoride
- Bismuth Fluoride
- Boron Trifluoride
- Boron Trifluoride Complexes
- Chromium Fluoride
- Copper Fluoborate
- Fluoboric Acid
- Fluorine Cells
- Fluorinating Agents
- Frosting Mixtures
- Hydrofluoric Acid Anhydrous
- Hydrofluoric Acid Aqueous
- Hydrofluosilicic Acid
- Lead Fluoborate
- Metallic Fluoborates
- Potassium Bifluoride
- Potassium Chromium Fluoride
- Potassium Fluoborate
- Potassium Fluoride
- Potassium Titanium Fluoride
- Silico Fluorides
- Sodium Fluoborate
- Tin Fluoborate
- Zinc Fluoborate
- Zinc Fluoride

WRITE FOR
Harshaw's 40-page Book on Hydrofluoric Acid Anhydrous. It provides helpful data.

THE HARSHAW CHEMICAL CO.
1945 East 97th Street • Cleveland 6, Ohio
Chicago • Cincinnati • Cleveland • Detroit • Houston
Los Angeles • Hastings-on-Hudson, N.Y. • Philadelphia
Pittsburgh

In the market for a header with cold extruded outlets?

The new FLUOR-FORMED *cold extrusion* process for producing header and vessel branch outlets by flowing unheated steel around the contours of a die offers many proven advantages over all other methods.

Send today for details.
Specify Bulletin CE-0.001.

FLUOR PRODUCTS COMPANY

A FLUOR-FORMED Product

MANUFACTURERS AND FABRICATORS OF COOLING TOWERS, PULSATION DAMPENERS, MUFFLERS, PREFABRICATED PIPING AND OTHER WOOD AND METAL PRODUCTS

A Division of The Fluor Corporation, Ltd.

General Offices – WHITTIER, CALIFORNIA

Wood Products Mill – SANTA ROSA, CALIFORNIA

Metal Fabrication Shops – PAOLA, KANSAS

SALES OFFICES *and* REPRESENTATIVES IN: Birmingham, Boston, Buffalo, Chicago, Denver, Detroit, Houston, Kansas City, Los Angeles, Minneapolis, New York, Philadelphia, Pittsburgh, San Francisco, Tulsa

ASSOCIATES: Fluor Corporation of Canada, Ltd., Toronto; Head-Wrightson Processes, Ltd., London, England

SPRINGFIELD GAS LIGHT CO.

STABILIZES BY REMOTE CONTROL

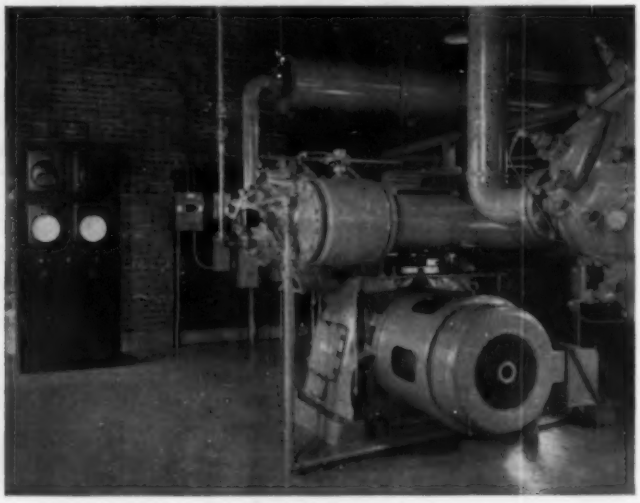
...with Foxboro TELETAX* Telemetering

Here's another modern utility that's assuring highest efficiency in a key operation through Foxboro Teletax Telemetering. Using this advanced supervisory control system, the superintendent at Springfield Gas Light Company's main plant has complete command of gas stabilizing operations at the city gate, three miles away. A B.T.U. Recorder continuously shows him the heating value of the gas; a Teletax Receiver indicates the air/gas ratio being maintained. If gas varies from pre-set B.T.U. value, he pushes a button either to raise or lower air-to-gas ratio and restore proper B.T.U. value.

This is only one of many Teletax installations, specifically engineered to meet a wide variety of requirements. Assure your operation highest efficiency and economy with Teletax . . . for transmission of *any* standard Foxboro Measurement over *any* transmission system. Write for Bulletin 17-11A. The Foxboro Company, 388 Norfolk Street, Foxboro, Mass., U.S.A.

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND.

Using Teletax Telemetering, the supervisor at Springfield Gas Light Co.'s main plant (above) controls desired, air/gas ratio at compressor station (below) three miles distant. The company purchases gas from the Tennessee Gas Transmission Company line, stabilizes it to maintain a constant B.T.U. value.



FOXBORO
Reg. U.S. Pat. Off.
TELETAX TELEMETERING

*Reg. U. S. Pat. Off.

STOP
PARAFFIN TROUBLE
with Visco 921

Buy Visco 921 Paraffin Dispersant for a lease where you have the worst paraffin build-up problem . . . Watch it, under any weather conditions, keep paraffin build-up out of tubing, pumps, pipes and tanks . . . at lowest cost per barrel of oil

OR

Ask your Visco Field Service Man for detailed reports on what Visco 921 is doing—efficiency- and cost-wise in paraffin-producing wells. Write or phone today for fast action. *We know you will be convinced!*

VISCO PRODUCTS COMPANY
INCORPORATED
2600 Nottingham at Kirby • Houston 5, Texas
Telephone MAdison 3-0433
Plants at Sugar Land, Texas, and Anaheim, California

Visco® CONSISTENTLY EFFICIENT OIL FIELD CHEMICALS

11 ALL-IMPORTANT FACTORS WHICH DETERMINE THE VALUE AND EFFICIENCY OF PROCESSING FURNACES

✔**UNIFORM HEAT DISTRIBUTION**
MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

✔**UNIFORM HEAT DISTRIBUTION** the most desirable heater characteristic is created in an Iso-Flow furnace by:

1. Individual burners are so spaced in relationship to the heating elements that they create a symmetrical flame pattern with relation to the tubes;

2. The metal cone at the top of the combustion chamber re-radiates to the tubes, also diverts combustion gases progressively closer to the tubes to give a uniform heat intensity at the upper portion of the combustion chamber;

3. The combustion gases, at the top of the heater, are diverted towards the walls where they recirculate from the top of the heater downward, behind and between the tubes, increasing the heat input to the rear of the heating elements by convection;

4. The recirculated gases reduce the heat intensity at the bottom of the furnace so that the heat input is the same, top and bottom.

These factors provide the completely uniform heat distribution required in heaters for the most efficient process operation.

In every case where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES *were proved most efficient by any comparison.*

Prove PETROCHEM-ISOFLOW FURNACES Most Efficient by Any Comparison

More than 1200 PETROCHEM-ISOFLOW FURNACES *are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petrochem-Isoflow Furnaces are pre-eminently satisfactory.*

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES:

Rawson & Co., *Houston* • Wm. H. Mason Co., *Tulsa* • Lester Oberholtz, *Los Angeles* • Faville-Levally, *Chicago* • D. D. Foster, *Pittsburgh* • Turbex, *Philadelphia* • Flagg, Brackett & Durgin, *Boston* • G. M. Wallace & Co., *Denver & Salt Lake City*

International Licensees and Representatives: SETEA—S.A. Comercial, Industrial, y de Estudios Tecnicos, *Buenos Aires, Argentina* • Industrial Proveedora, *Caracas, Venezuela* • Societe Anonyme Huerley, *Paris, France* • Societe Anonyme Belge, *Liege, Belgium* • Huerley Italiana S.P.A., *Milan, Italy* • Birwelco Ltd., *Birmingham, England*

Here is a new management tool that can be used any place — in the office, the store, the factory, the home, the civic club, the church. It can be used in a group or individually.

The author, a successful industrial relations counselor, has developed a practical method of working out any question that confronts you in dealing with people.

If you have ever been in a spot where you didn't know what to do you'll appreciate this seven-step path to the best possible action.

You Can Solve That Problem!

Dallas Belcher

Dr. Anthony! I have a problem!

How often have we wished we had a Dr. Anthony handy to give us the answers to a problem situation. We are frequently faced with important decisions in our business relationships, in our personal lives and in our community or church activities.

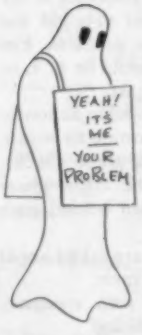
Occasionally we are haunted by the disturbing thought, "Did I handle that right? Was there some other action that would have brought better results?"

At other times the problem may be so difficult that we do not know where to start. We spend valuable energy running here and there mentally, and end up frustrated and solutionless or at best, with only a partial answer.

These experiences are common. Would you like to know how to solve them? Here is one problem-solving technique that has been found workable for most problems people face.

This seven-step problem-solving method may seem a bit cumbersome at first, but as one practices it, the whole process molds into a smooth, useable pattern. Try it first on a simple question and see how it works. It can be a personal or business or a community problem. It can be used at a family conference as well as at a board of directors meeting although it is essentially a management tool.

After you have tried it out use it on any important problem and you will be happily surprised at the results.



STEP 1. Recognize the Problem.

Exactly what is the problem? Get clearly in mind what specific situation causes you to feel that something is wrong and calls for action. Decide how this can be stated clearly. Next write a statement of the problem in the upper left corner of the worksheet as shown in Fig. 1.

This statement should be clear-cut and concise, such as: The L. D. telephone bill was $2500.00 last month, or Adrian has been late three mornings this week; or, production reports take two days to reach Mr. James; or, the sixth floor must wait 5 minutes for the elevator at lunch time, or, a memo was lost for four days; or, the no smoking rule has been violated, etc.

One pitfall to avoid is the tendency to generalize in stating the problem, such as: The L. D. telephone bill was too big; or, Adrian has a habit of tardiness; or, our communication system is faulty. When we state general assumptions such as these, we are prejudging the case and may be jumping to an unwarranted conclusion. Facts might bring out the conclusion that $2500.00 is not excessive for long distance calls if they were all necessary. Adrian may not have a habit of tardiness, but a series of circumstances beyond her control may have caused the three incidents of tardiness. Put down the simple statement of the fact in Step I and let Step II take care of whether the bill is too large or not, or whether Adrian was willfully late or not.

STEP II. List the Facts.

Just below the statement of the problem the heading "Facts" is written. Under this heading all pertinent facts relating to the problem are listed on the worksheet. Remember that all statements must be factual and not assumptions nor generalities. In order to dig out more facts ask yourself questions or ask others who are working with you.

Questions that should help to present a clearer picture of the problem might well be:

EXCLUSIVE

When did the troublesome situation begin?

How long has it been going on?

What are the ages of the persons involved?

What company practices were involved?

What do the persons concerned say about the problem?

Would knowledge of the background of the person involved help to understand the situation better?

What good things can be said of the individuals?

The main reason for writing down the facts in Step II is so that they may be evaluated more accurately in Step III. It is difficult for most people to keep more than one thought or fact in focus by memory. To evaluate or weigh items or ideas, more than one fact must be in view at the same time.

Another reason for writing the basic facts down is that it enables a person to look at all sides of the problem more objectively. Both good and bad aspects of a situation need to be weighed. If the facts are not written it is easier for the emotions to color the situation and prevent us from forming a sound judgment.

STEP III. Weigh the Facts.

The weighing process is simply reviewing the facts to determine which are the most important to keep in mind and which have the greatest bearing on solving the problem. Check the more important facts to make them stand out from the others, or number the facts in order of their importance. Go over the list again to determine if there are any gaps or contradictions in the story. If any discrepancies are found they should be straightened out before going on.

STEP IV. Determine Objective.

After the facts have been thoroughly weighed, the final result desired is listed on the lower left side of the worksheet. (This statement frequently is in two parts: The immediate objective and the long term objective.) We ask ourselves: "Just what do we want to accomplish? What do we want to happen as a result of the action we decide to take?"

STEP V. Make a Decision.

In order to arrive at the best possible decision try to have a large number of possible actions to choose from. Write down under the heading "Possible Actions" all the ways of obtaining the objective you can think of.

Don't judge the worth of any possible action until every one is listed. Throw in a few impossibles if you want to. They may give you a useful idea. Later on in the process of problem solving, each possible action will be evaluated, but at the time of listing them, don't criticize or judge the suggestions.

Our minds are made up of two major divisions so far as our thought process is concerned. One function is creative and the other judicial. The creative portion of our mind functions most efficiently when ideas are allowed to flow freely. You can stop the flow of ideas by beginning to judge them. So write down all possible actions — good, bad or indifferent — before checking to see which action or actions may do the best job of solving the problem. For most problems there should be 6, 8, or 10 possible actions at least.

Now subject each possible action to a five-point test to determine its worth. To record the results of these checks, space is reserved at the right where five squares are provided behind each possible action.

These five questions are asked about each possible action in turn:

1. *Is it in accord with company practices and policies?*
2. *Will it accomplish the objective?*
3. *Will it have a good effect on the individual?*
4. *Will it have a good effect on the group involved?*
5. *Will it have a good effect on production?*

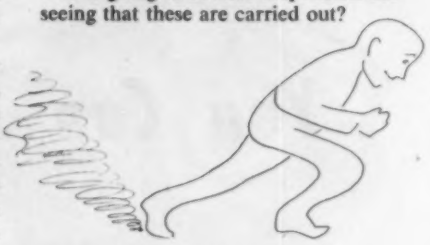
If a possible action rates a plus on each of these checks it should be a good move to make. It may be that there are several possible actions which rate plus on all five checks. If this should be the case, consideration would have to be given as to which would be the best or first action to take or what combination of good ones might be made.

If none of the possible actions are plus in all squares, then the one with the least number of minuses is generally the move to follow.

If the problem is one of family concern or church concern, the word "family" or "church" could be substituted for "company" in the first check question. The fifth question could be worded to read: "Will it have a good effect on family harmony?" or, a church group might revise it to "Is it the Christian thing to do?"

Sometimes it is impossible to give an unqualified plus or minus, yes or no, in answer to a possible action so any symbol may be used to record your decision, such as: ½, both plus and minus, big plus and little minus, big minus and little plus, ?, 0 if no effect, etc.

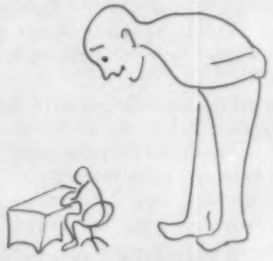
After all squares are filled in, the best possible action generally stands out like a "sore thumb" and can be easily recognized, so the next question asked is: Which possible action or combination of actions is best to take, and who is going to be held responsible for seeing that these are carried out?



STEP VI. Take Action.

All the decisions in the world will not accomplish anything unless they are followed by action. After determining which action is to be taken then certain questions must be answered such as: "When should the action be taken? How may we go about taking the action?"

The next thing to do is to act.



STEP VII. Check Results

Two human beings frequently react differently to the same stimulus, so when action is taken the results must be watched carefully. The first question asked is, "How soon should results be evident?"

In some cases a change in attitude or output should be evident immediately. If the change, resulting from the first action chosen is not satisfactory, then possibly the second action should be taken and its results observed.

A supervisor in the shop, field or office finds himself in the same position as a doctor at times. He must be alert to the results obtained by the use of a particular action. If the proposed

FIG. 1.

PROBLEM SOLVING

I **PROBLEM:** Tom Jones ordered pumps on emergency basis

II **FACTS:**

1. Tom Jones is lease foreman in Eldorado, Arkansas.
2. Decided he needed 2 more oil field pumps.
3. ordered them at full list price plus freight from local supplier.
4. T. J failed to determine whether pumps were in local stock.
5. 1 pump shipped from Houston one week later.
6. 1 pump shipped from Los Angeles five weeks later.
7. pumps list at $285 ea plus freight.
8. company discount is 25% off list plus transportation
9. company supplier had pumps in stock
10. needed one pump to clean tanks and the other to pump fresh water for a work over.
11. to permit emergency purchases in the field.
12. the term "emergency" has not been clearly defined to employees.

III **WEIGH THE FACTS:**

Any gaps or contradictions?

IV **OBJECTIVE:** to get urgently needed equipment to field quickest as possible. Keep cost to minimum.

Date: 2/21/56

V **MAKE A DECISION:**

Possible Actions:	PRACTICES P	OBJECTIVE O	INDIVIDUAL I	GROUP G	PRODUCTION P
(1) allow no emergency field purchase	+	−	−	−	−
(2) All purchasing done by home office	+	−	+	+	+
(3) Set up local warehouse	−	−	+	+	+
(4) set up a careful definition of "emergency"	+	+	+	+	+
(5) Set approval of home office for all purchases over # 50 ea	+	+	+	+	+
(6) Bawl out Tom Jones	−	−	−	−	−
(7) Fire Tom Jones	−	−	−	−	−
(8) eliminate local purchases when in stock locally	+	+	+	+	?
(9) Require lease foreman to plan ahead	+	+	+	+	+
(10) Deduct difference in cost of pumps from his salary	+/−	−	−	−	−
(11) corrective conference with Tom Jones	+	+/−	+	0	0
(12) Recommend emergency purchase systems through home office	+	+	+	+	+/−

Which? 4 - 5 - 8 - 9 - 12

Who? Home office Management + field

VI **TAKE ACTION:**

When? at once

How? Management directive and field Trips

VII **CHECK RESULTS:**

Did your action help production?

SIGNED: Rod Colton

Title Gen. Supt. Dept. Prod

This is a business problem actually worked out by the seven-step method. Your work-sheet should look about like this. Although this particular problem is in industry, you can solve your individual and family problems on the same type sheet. Management could run off forms and distribute them to supervisors to be readily available when problems arise.

action did not get the desired results he may have to re-think his problem. He may have had insufficient facts or the situation may have become more severe and more drastic action will be needed.

In a majority of cases, however, he will find that by thoroughly thinking the problem through, he has been able to take appropriate action and achieve a happy result.

To illustrate the use of this method of thinking through problems, we will take one that did happen to one company, and possibly could happen in others. All names and locations are changed.

Tom Jones was a farm boss near Eldorado, Arkansas. On his lease the men were using a lot of time hauling a small oil field pump back and forth when they wanted to clean a tank on one end of the property or pump water several miles away. Often it was inconvenient or work was held up. Tom saw he needed two more pumps right away.

Company policy permits the purchase of emergency supplies locally, but the term emergency had never been clearly defined to the men in the field. Tom decided this was an emergency and placed the order for the pumps, at full price, with a local dealer who did not stock them. One week later one pump was shipped from Houston and five weeks later the other pump was shipped from Los Angeles, California. The regular company supplier had the pumps in stock and could have shipped both pumps in two days from a warehouse within 100 miles of Eldorado. The regular supplier gives a company discount of 25 per cent off list, plus freight. The pumps list at $285.00. The home office became aware of the transaction when the invoice for the first pump was received for payment.

Here is the way General Superintendent Rod Cotton worked this problem out, using the seven-step procedure. (Fig. 1.) We will follow Rod's thinking as he developed the problem chart.

The situation that was wrong was that *"Tom Jones had ordered pumps locally, considering the situation an emergency."* To Rod it didn't look like an emergency purchase because nothing had broken down and production would not have been stopped. Also it took longer to get the pumps locally than it would have through the regular company supplier. Rod stated the problem as an action that should not have taken place. Tom should not have considered this an emergency purchase and ordered the pumps locally, especially without checking to be sure he could get immediate delivery.

The second step consisted of listing all the pertinent facts that Rod could think of. He tried to look at all sides of the picture and in fact in No. 12, he assumes part of the responsibility for the problem.

The next step consisted of "weighing the facts." To do this Rod looked over all the facts after he had them written down and decided that the key facts were Nos. 3, 8, 9, 11, and 12. He also thought No. 4 was important, but didn't mark it for some reason. He checked the facts for gaps in the story or contradictions. To him it looked like an error in judgment, coupled with none-too-clear directives from the home office.

His next move was to determine what overall result he wanted to accomplish. He decided that if he could get urgently needed equipment to the field quickly and still keep the cost down without abusing the term "emergency" he would feel that the problem would be solved.

At this point, Rod was ready to begin his creative thinking so he called in several other men from the company who would be directly or indirectly involved and they began to list possible actions that might be taken.

They were careful not to criticize any possible action suggested, but allowed the creative part of their minds to work freely. They came up with 12 things that could possibly be done. Some overlapped, but as each had a distinct idea behind it, it was written just as suggested.

After all the actions they could think of had been written down, Rod began to apply the five-point check against each possibility.

His thinking on No. 1 possible action ran something like this:

"Is it in accord with the practices and policies of the company? Yes, the company could set up that plan so I'll put a plus there. It wouldn't accomplish the objective of getting urgently needed equipment to the field as quickly as possible in all cases, especially where the repairs are available immediately from a local source, so I'll put a minus there. Would it be good for the individual, such as Tom? No, he would be handicapped unless the repair wasn't available locally. It probably would restrict his ability to do us a good job in the field and it would not be good for our other lease foremen — neither would it be good for production."

Rod went through each possible action, asking himself the five-check questions about each suggestion. Where he thought the answer was yes he put a plus, and where he thought the answer was no he put a minus. In those cases where he thought the possible action would have no bearing on the group and the group's production as in No. 11, he wrote a "O." In No. 8 he wasn't sure what that action would do to production, so he put a "?." Where there were two possibilities such as in No. 10 and No. 12, he put a big plus and a small minus to indicate that the "yes" was stronger than the "no" answer.

After going down through all the possible actions in this manner, a few appeared to be favorable because they contained the most pluses. So when asking himself which possible actions to take, he chose 4, 5, 8, 9 and 12, as having the best chance of accomplishing the objective and eliminating the possibility of problems like this one coming up again.

He decided that home office management and the field staff should be aware of the decision. His next step in taking action, was to decide to get out a management directive, get it OK'ed and sent to everyone. Then on his visits to the field, and in discussions with his lease foremen, he will review the directive with them and answer questions about it, checking each foreman as to his understanding of the term "emergency."

The actions Rod took solved his problem satisfactorily and his stress on action No. 9 has resulted in a substantial decrease in emergency requests. This decrease has enabled the company to buy repairs at a better discount and reduce the production time lost through breakdowns.

Industry and life itself pays its biggest bonuses to the person who can think straight and whose judgment is right the majority of the time. The use of this seven-step method of solving problems may be the tool that will enable you to reach a higher level of prosperity and success. ★ ★ ★

The Author

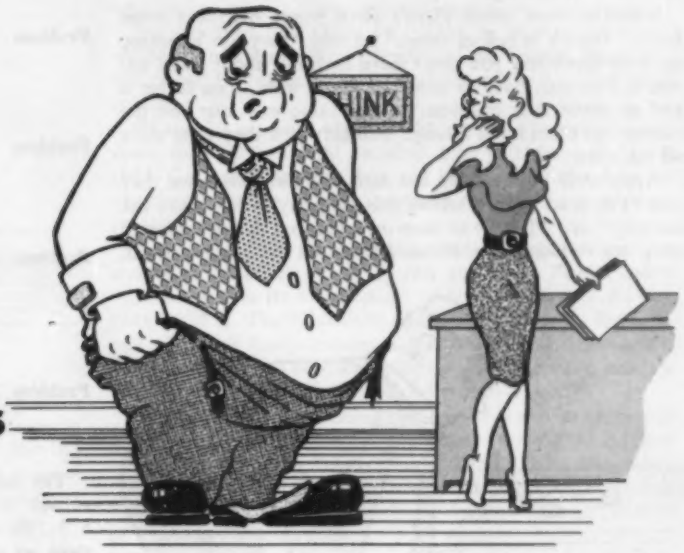
Dallas L. Belcher, director of training and public relations for Reserve Life Insurance Company, Dallas, Texas, was formerly a member of the Engineering Extension Service staff of Texas A & M College system.

He received graduate degrees from the Universities of North Dakota and Minnesota, majoring in industrial psychology and administration. Active in the field of adult education for the past 16 years he is also a consultant and speaker on employee relations as well as a widely read author of articles and text books on adult education.

Eighth of a series

Communication:

Creative Thinking In Business



Problem arises.

Dennis Murphy*

SIR Henry Irving, the English actor, was once a witness for the prosecution in a criminal case. The defense attorney tried to browbeat and confuse him.

"At what hour," he asked, "did you see this occur?"

"I think —" began Sir Henry. The barrister interrupted with shouts.

"No one cares what you *think!* It's what you *know* that matters!"

"Don't you care to hear what I *think?*" asked the famous witness.

"We certainly do not!" snapped the lawyer.

"Then I may as well leave the witness box," said the actor. "I can't talk without thinking. I'm not a lawyer!"

Skill in communication includes many skills: thinking, observing, talking, listening, writing, and reading. But *thinking* comes first because it's basic to all the others.

What Is Creative Thinking?

James Harvey Robinson, the historian, recognized four types of thinking:

1. **Daydreaming, or reverie.**
2. **Making decisions.**
3. **Rationalizing to support what we already believe.**
4. **Thinking that causes us to change our minds.**

Logical thinking is an ability to draw sound conclusions from premises, to extract universal truth from individual cases, and to infer particulars from general laws. We use statistics, actual surveys, mathematical equations, valid reports, and relevant facts to help us in our reasoning processes.

But creative thinking — what is it? Someone said, "Talent is doing easily what others find difficult; genius is doing easily what seems impossible." Great creativity has been accounted for as biological variation that permits the achievement of great things without the awareness of it. And it occurs in varying degrees in individuals. According to Alex Osburn, all of us have the power to think creatively — women as well as men, the old as well as the young.

Whatever creative thinking is, it uses sensation, perception, imagination, intuition, and free association of impressions. Whether this thinking is derivative or accidental, it adds to our body of permanent knowledge and helps to solve our problems. As one quip goes, "Nothing is impossible — but some people are!"

Creative thinking in business and industry, as we use the term, does not imply the extraordinary genius that motivated Shakespeare, Mozart, or Einstein. It implies, rather, our ingenuity to produce unusual solutions to ordinary problems that baffle us on our jobs every day. It's more like the ability Ulysses used in getting himself out of "holes," or difficulties, in *The Odyssey*. It operates in all research, new ideas for production, decision-making, and problem-solving.

Where Do We Get New Ideas?

Edison said he got new ideas out of the air and distrusted calculated thinking. Hollis Thurston, the baseball scout who discovered Kiner, Minoso, Rivera, and other players, once said, "Like most scouts, I trust my first impression more than I do any later checks and balances."

*Dr. Murphy is administrative assistant, Service Pipe Line Company.

Constantly we hear about individuals who have resolved their major problems abruptly out of the blue or seemingly without any logical decision. The late Louis Bromfield said, "I always trust the decisions of my inner-mind over any judgment arrived at through a long and reasonable process of conscious thinking."

Irving Langmuir, research chemist for many years with General Electric Laboratories, wrote: "In almost every scientific problem which I have succeeded in solving, even those that have involved days and months of work, the final solution has come to my mind by a process which is, consciously, not one of reasoning."

Someone once asked Henry Ford where his ideas came from. "The air is full of them," he said; "they are knocking on your head and you don't have to think about them too much. You only have to know what you want, then forget it and go about your business." In the same way, our best decisions will often burst through suddenly as if they were there all the time.

Apparently businessmen use their subconscious when they say, "I'm dead against selling this property — but don't ask me why!" or, "I'll have to sleep on it before I decide." During sleep our subconscious, released from the shackling intellect,

What to do?

can exercise freely. Undoubtedly too much mulling, reasoning, and calculating thwart our decision-making. And we know that many men unschooled in logic and reasoning have come up with some mighty fine decisions.

Can You Solve These Brain-Teasers?

An inventor has been defined as a fellow who doesn't take his formal education too seriously. In fact, too much formal education can cause mental blocking. Here are some "old chestnuts" you can test yourself on:

Problem 1 — Get a ping-pong ball out of a 2-inch rusty pipe 2 feet high and welded upright to the floor. (In the room are hammer, plyers, string, wire, fishhooks, a table, a crystal pitcher of ice water, a tumbler, and a chair.)

Problem 2 — Make four equilateral triangles by using 6 matches. (We visualize them in the same plane, can't get beyond our preconception, and grow frustrated by our mental block.)

Problem 3 — Drive a loaded truck through an underpass that lacks ½ inch of clearance. (Any old curb-sitter can tell you how!)

Problem 4 — Measure out 100 cc of water, a pitcher full, by using three containers holding 21, 127, and 3 cc.

Problem 5 — Measure out 20 cc of water from three jars of 23, 49, and 3 cc. (Many people needlessly use the 49-cc jar for this one!)

Problem 6 — Drive your car home after someone steals all six lugs off one of its wheels. (Maybe you've heard the joke about the inmate of an insane asylum who told his superintendent how to do this!)

Problem 7 — Connect all nine dots of a square by . . . drawing four straight lines. Don't re- . . . trace or remove pencil from paper. . . . (Don't fence yourself in!)

Problem 8 — Find the smallest number that can be divided evenly by 7, but leaves a remainder of 1 when divided by 2, 3, 4, 5, or 6. (There are several methods of arising at the right answer.)

Problem 9 — Discover what a suicide victim stood on to hang himself with a rope. (The room was barren — no table, chair, bench, box, or anything else in it. Only a large puddle of water on the floor.)

Problem 10 — John is 24. He is twice as old as Bill was when John was as old as Bill is now. How old is Bill?

The point of all this: Blocks to our creative thinking are caused by the way we **feel** about things (as in problems 1, 6, 9), the way we **see** things (problems 2, 3, 7) and the way we **think we ought** to go about things (problems 4, 5, 8, 10).

Psychologists have only recently begun to explore **how** and **why** we think as we do, but they have discovered some internal forces we overlook or shunt aside in our daily lives. And while we keep certain other impulses stored up in our cerebral cell-circuits, they often cause mental blocks that hamper adventurous thinking. Although we handle routine thinking well enough to get by, we rarely break out of our grooves of conventional thought.

Creative Thinking in Business

The main purpose of creative thinking in industrial research, of course, is to make money. New ideas should be stimulated in business to achieve maximum productivity, but they also have other values. Without underrating logical and judicial thinking, we need more creativity to help us (1) solve problems, (2) make decisions, (3) generate new ideas, and (4) vitalize work.

None of us knows too much about the living brain and its processes; and creative thinking is an activity to be learned rather than taught. But we know we can borrow and **adapt** ideas to new uses; **modify** ideas by giving them a new twist; **enlarge** an idea by adding other ideas to it; or **strip it down** by subtracting from or dividing it.

We also know we can change and **rearrange** the pattern; **reverse** certain elements; **substitute** this element for that one; and **combine** alien or foreign elements into a new composite. We also know we can leave a problem and come back, attacking it afresh from a different angle. And often we come up with the very idea needed — just in the nick of time. Many people do their best thinking under pressure. They have to!

All thinking is hard work, especially so if it's creative. We know, too, that its chief enemies are laziness and inertia, tradition and custom, ridicule and fear of being different from

Bright ideal

others, lack of confidence in our abilities, and adherence to convention or conformity. Attitudes or I-don't-care and let-well-enough-alone are certainly no help. One mark of an educated man, said the psychologist, Albert Edward Wiggam, is that he never pooh-poohs anyone else's "wild" ideas or dreams.

One classic example occurred in 1867 when a boyish inventor tried to sell his idea of an air-brake to Cornelius Vanderbilt, then president of the New York Central.

"Do you mean to tell me you can stop a railroad by wind?"

"Since air is wind," said young George Westinghouse, "the answer is yes."

"Nonsense," roared Vanderbilt. "I have no time to waste on such a fool idea!"

Yet in a few years the Pennsylvania Railroad introduced the first automatic air-brake to the world.

Rudolf Flesch, in his *Art of Clear Thinking*, says that error is often more popular, attractive, and comfortable to believe than truth. Yet while we learn to combat the enemies of creative thinking, we also learn to offset the enemies of clear thinking.

Fundamental Steps in the Creative Process

1. **Recognition** of a need, change, or problem comes before any creative effort. If we sense no waste, for example, we're not very likely to originate anything that will eliminate waste.

2. **Preparation** consists of collecting the necessary information we must sort, arrange, and bring into play. We find new solutions in those areas we know most about; an industrial engineer, for example, is not expected to be creative in organic chemical research.

3. **Incubation** in the subconscious mind is important. Our conscious mind is the center of logical thinking because it deals with known ideas. But our subconscious mind, in moments of reverie and relaxation, sparks the new ideas.

4. **Illumination** is a sudden ray of solution, often fleeting and elusive, that we should jot down then and there or our conscious mind may never be able to recall it.

5. **Verification** through logical facts or experimentation is a crucial period in creativity. Here our open mind must reject all the conditioned thinking, stock responses, traditional experiences, and customary attitudes that have been built up in our logical mind.

What Companies Are Using Creativity?

Many organizations today are looking for ways to increase creative thinking not only among supervisors but also among those supervised. General Electric and Armour have active programs. MIT, USC, and other colleges offer courses in creativity; and the University of Chicago has psychologists who are studying the uses of intuitive thinking in industry.

An article in *Life* (May 16, 1955) by Morton M. Hunt, entitled "The Course Where Students Lose Earthly Shackles," tells about Professor John Arnold's course in Creative Engineering at MIT.

Of the 70 students who took this course in the past five years, over 20 now hold excellent jobs with firms like GM, IBM, GE, and Corning Glass and have rolled up a long list of original designs — from a special tractor to a new surgical instrument.

One company's adventures in "brainstorming" are described in an article by C. F. Hix and D. L. Purdy, called "Creativity Can Be Developed," in *General Electric Review* (May, 1955). The Education and Training Section for General Electric's many engineers has set up and developed a Creative Approach Seminar, a group that meets two hours a week for 16 weeks. It handles three groups a year.

Participants in this seminar discuss ways to improve old products and spark ideas for new ones. Leaving the judicial and critical portions of their thinking behind them, they work creatively and uninhibitedly toward a problem's solution. They also study many tested techniques that increase the flow of problem-solving ideas.

Members of this seminar recorded these stages in their approach:

1. **Recognize the problem — and write it down.**
2. **Define it by preparing specifications.**
3. **Search for as many solutions as possible.**
4. **Evaluate all of these carefully.**
5. **Select one and focus on it, the possible best one.**
6. **Make a preliminary design for it.**
7. **Demonstrate it.**
8. **Follow through by testing it.**

By the end of the seminar each member easily completes at least 20 ideas on a typical design problem. The group learns to use team techniques. A single "brainstorm" session causes 50 to 150 ideas to originate as fast as the men can write them down. One brainstorm produced 175 ideas in less than 30 minutes! If one idea out of 100 is usable, one out of 1000 is an improvement, and one out of 10,000 is an original "find" — the returns are considered tremendous. Maybe that's why GE's slogan is: "Progress is our most important product."

Petroleum scientists and engineers have come up with hundreds of new products and improved many others through research laboratories and modern techniques that stimulate creative thinking. Standard Oil Company (Indiana), for example, has groups of scientists who meet informally in creative sessions. Through "brainstorming" and other devices, these men "pop" new ideas all the faster because one idea sparks another.

The Ethyl Corporation also has an idea-generating program within its own organization and helps customer oil com-

panies in this new kind of service. Many other oil companies — and many companies in other industries — have creative research programs that allow young scientists and engineers to make specific contributions and build satisfying careers.

Anyone who visited General Motors Powerama saw a few of the practical results of creative thinking as they affect our living today and in the future. And, as Dr. Charles F. Kettering says, "We should all be interested in the future because that's where we're going to spend the rest of our lives."

What Can Management Do About It?

Many factors must be considered to determine the need and extent of creative research: Size of the company, the nature of its product or service, its competition in the market, its personnel, and so on. One company may survive on the creative ideas that its management can supply; another may need to stimulate a constant influx of new ideas.

Managers looking for newer and better ways of doing

Problem solved.

things have long used **suggestion boxes** or **cash awards.** In a company-wide suggestion system, employees are rewarded for money-saving ideas they suggest. But managers should administer cash awards with the utmost finesse, or they may create more problems than they can solve!

In the oil industry, especially, research is usually a group effort so highly complicated that management could hardly make cash awards on any equitable basis. Sometimes managers pay outside consultants to bring in new ideas, but they owe no extra money to inside research workers whose very job it is to generate ideas. Yet a company usually pays its men according to the ideas produced.

Often industry promotes the ingenious employee to a management job, at the same time smothering his imagination and inventiveness with the routine of statistics, system, and control. And while industry develops a few exceptional men, it neglects many who get trapped in a system that tends to suppress their potential talent.

Since creative talent is so highly valuable, all managers should keep an eye out for this valuable asset in human resources — the natural creativity in the **average** man. And first-line supervisors are in a much better position to observe it than top management!

With our growth in population and its greater demand for production from a smaller proportion of workers in the future, the pressure is on for increased output per man-hour. This step-up will call for new methods and manufacturing techniques. So, improvement is not a fad but a fundamental. Managers, then, must take creativity out of the realm of uncertainty and adopt new attitudes toward it. They must realize that time spent on new ideas is time profitably spent.

Communication Is the Key

Dr. Norman Vincent Peale defines creative thinking as healthy thinking that will improve our conditions. Employees **do** have fresh ideas and **are** interested in improvements. Everyone likes to improve; that's the nature of men. And all employees find their greatest pleasure when they can think, improve, communicate, and produce with others.

How can management stimulate the right atmosphere so that creativity can emerge and thrive usefully?

1. *Encourage free and informal communication among all levels.*
2. *Discourage the "crash" or emergency approach in solving problems.*
3. *Develop optimistic attitudes instead of complacent and negative ones.*
4. *Question any policy of promotion that may stifle creativity.*
5. *Encourage new points of view through every form of communication — especially in creative research seminars that cut through all levels.*

Creativity in a company rests largely upon: (1) the friendly freedom to think up and talk up to others, (2) the interchange of ideas among men with a variety of backgrounds and experiences so they can stimulate and assist each other, and (3) the free-flow communication that allows each employee to contribute his best. Workers like to contribute new ideas and experience a sense of contributing. Training programs fizzle out when the participants themselves aren't consulted about the kind of training they desire and need.

What does all this mean to the manager? He must turn to the techniques of joint action and participation if he wants to effect creative thinking. Democracy in business depends on a fundamental faith and belief in employees. Each manager must find releases for their latent talents and abilities for worthwhile purposes if he is to utilize the full human potential and human resources at his command.

References:

Brinton, Crane. **Shaping of the Modern Mind.** New American Library, 1953.

Crawford, Robert P. **Techniques of Creative Thinking.** Hawthorn Books, Inc., 1954.

Curtis & Greenslet. **The Practical Cogitator.** Boston: Houghton, Mifflin, 1953.

Editors of Fortune. **The Mighty Force of Research.** McGraw-Hill, 1956.

Flesch, Rudolf. **The Art of Clear Thinking.** Harper, 1951.

Ghiseln, Brewster (ed.) **The Creative Process.** New American Library, 1955.

Hutchinson, Eliot D. **How to Think Creatively.** Abingdon-Cokesbury, 1949.

Keyes, Kenneth S., Jr. **How to Develop Your Thinking Ability.** McGraw-Hill, 1950.

Mander, A. E. **Logic for the Millions.** Philosophical Library, 1947.

Osborn, Alex F. **Your Creative Power.** Scribners, 1948.

Osborn, Alex F. **Applied Imagination: Principles and Procedures of Creative Thinking.** Scribners, 1954.

Overstreet, H. A. **The Mature Mind.** W. W. Norton, 1949.

Robinson, James H. **The Mind in the Making.** Harper, 1939.

Thouless, Robert H. **How to Think Straight.** Simon & Schuster, 1950.

Walter, W. Grey. **The Living Brain.** W. W. Norton, 1953. ★ ★ ★

How can you learn what the free enterprise system is except by putting it to work? Some 2000 companies, many in the oil industry, help teen-agers form and operate their own companies. You can't imagine a better school for individual enterprise. Now is the time to get ready if you want to help this fall. This is a brief review of a New Orleans company which Pan-Am personnel advised

Robert J. McCoy, Jr., left, vice president and production manager for Nola Nic Nacs Company, operates saw in Junior Achievement meeting room to cut wheels from a piece of round wood. Jerry Heslin studies technique. In production and management they learn by doing.

The Classroom That Isn't

THE topmost floor of a New Orleans office building was hurriedly renovated for a promising group of tenants. While the smell of fresh paint still smarted their nostrils, the anxious newcomers gathered around long tables and within one week formed 24 new corporations. The rush was understandable. They wanted to enter the race for the customer's Christmas dollar.

The city's fellow businessmen were not grumbling about the new competition. Instead, they were tickled pink. Many sent their own employees to act as technical advisors and thus help the new firms get a healthy start.

This same spirit of cooperation has been repeated time and again across the nation wherever Junior Achievement has set up shop. The purpose is simple and effective: Let our teenagers see the complete picture of American business under the free enterprise system by having them operate their own realistic companies.

Stock Sales Raise Capital

The 16 high school students who banded together under the name of Nola Nic Nacs Company soon learned that Junior Achievement was not merely a game to occupy their spare time. When they asked where the company's money would come from they were told they would have to sell stock at 50 cents a share. In order to do this it would be necessary to convince potential investors that their cash would be in good hands and probably earn added dividends within a few months. There was little chance of one generous relative putting up the entire $100 capital needed by the company. By-laws prohibit any one person from owning more than five shares of stock.

Today, after overcoming the dozens of problems which plague any new business, Nola Nic Nacs is a healthy, busy company. A member of the sales staff, operating on a commission basis, will gladly call at your door to offer the company's latest product: a neat slate board, ideal as a child's toy or as a handy reminder board for the kitchen wall. Costume jewelry made from sea shells are also for sale. There may even be a brightly colored wooden train left over from the Christmas toy rush.

The true value of the nation's 2000 Junior Achievement companies is that each operates exactly like a bonafide in-

This article is reprinted from *The Pan-Am Southerner*, January 1956.

Member of Nola Nic Nacs tacks cabs on top train and another member aligns the side posts of what eventually was a flat car for the train.

Tedious bookwork in keeping company records includes making stock certificates. Henry Czerwinski, left, industrial relations director at Destrehan, signs the stock certificates as advisor on business administration. Center is president Henry Cormier, Jr., right is treasurer, Maxine Oldendorf.

Carl Peters, right, chief process engineer at Destrehan, acts as production adviser for Nola Nic Nacs. Here he examines first model of slate board for possible production by the company. It turned out to be simple to manufacture.

dependent business. Officers are elected and wages must be paid to the members for their labors during the weekly meeting nights. Financial statements are issued each month. Rent must be paid on the meeting room as well as on the machines used to make the company's products. When the firms are liquidated at the close of the school term, inventories and supplies are sold and debts settled. Then the dividends, if any, are paid to stockholders.

Business Men Advise Only

As a helping hand along this labyrinth of economical traps, each Junior Achievement company is assigned a business firm as a sponsor. Pan-Am Southern Corporation guides the Nola Nic Nacs group. Three Pan-Am Southerners donate their spare time each week to serve as advisors. Henry Czerwinski, Destrehan Refinery, is aiding with business administration. Robert Mackey, general office, is sales advisor and Carl Peters, Destrehan, tackles the headaches of production. Each one makes it a point to do no more than suggest possible solutions. The decisions must be made by the officials of the company.

Charles "Art" Cormier, the current president of Nola Nic Nacs, is 17. When he was elected he blushed before his fellow businessmen and said, "Gosh, I've never done anything like this before."

By the end of the third week he was huddling with his managers of sales and production to find out the unit cost of each item being produced so that a profitable retail price could be established.

Can Go Broke

The best proof of the reality found in Junior Achievement is the fact that J. A. companies suffer about the same morality rate as found in the business world. Some must declare bankruptcy or give only partial returns to stockholders because of poor sales.

Either through success or failure, the Junior Achievers are learning by doing. They are learning what makes the business world tick, the risks, the responsibility and the adventure. They are also learning that money is valuable and carries certain privileges.

On the night that Nola Nic Nacs was chartered, the members were notified that rental charges on their meeting room had already begun. A 15-year-old girl noticed that when their door was closed it could not be opened from the outside because of a faulty catch. Said she: "If we're paying rent it seems we should have a right to ask that the door be repaired."

Next week, the door was operating nicely. ★ ★ ★

OIL *and the* INDEPENDENT OPERATOR

A. E. Herrmann

The role of the independent oil operator, or — if the more colorful name is preferred —wildcatter, was most adequately summed up a few years ago in a report prepared by a committee of the United States Senate:

> . . . in a large measure is American primacy (in oil) owing to the wildcatter . . . who on a shoe string and a prayer doggedly drills his well, be it dry hole or East Texas. Probably two-thirds of the wildcat wells in the country are drilled by independent operators as distinguished from the 20 or so major companies. Hence it is obvious that the functioning of the independent companies is indispensible to a healthy industry. The independent company must be permitted to prosper if for no other reason than to prevent a drift into monopolistic practices with resultant governmental intervention.

So closely is the small, independent operator associated with risk drilling and the discovery of oil that the name *wildcatter* has become almost synonymous with the independents who operate on the proverbial shoe string.

The independent is the man who doesn't require mathematical assurances of success before venturing his capital and energy in the highly uncertain business of finding and producing the oil vital to his Nation's needs for peace and war.

Admittedly, larger integrated companies likewise engage in the drilling of wildcat wells, but they do so — for the most part — in the highly conservative manner that has become a necessity for big business. A certain portion of major company funds are budgeted for wildcatting each year, and whatever profits accrue from this activity are divided among other operations of the organization. The independent, on the other hand, generally takes the money (if any) that he makes from a wildcat strike and immediately sets about to find more oil.

The risk an independent operator takes when he sinks the bit into wildcat ground is all the more apparent when it is considered that only about 1 out of every 8 such ventures produce oil in commercial quantities. In 1955, for example, 1425 of the 11,480 wildcat wells drilled throughout the United States were successful producers.

Texas wildcatters, a little more successful than their counterparts across the country in 1955, hit about 1 out of every 7, finding oil in 681 of their 4860 attempts. For 1956, indications are that the total number of wildcats drilled in the state will be slightly more than 5600.

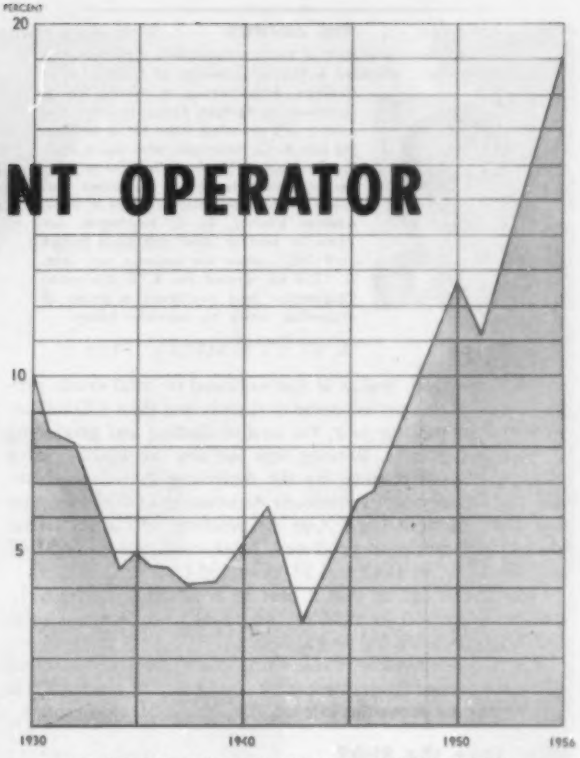
Wildcatting, on a big scale, simply doesn't pay. Consequently, while major companies render an indispensable service, their greatest contribution is not in the province of wildcatting.

This, then, is the happy hunting ground of the more than 20,000 small companies, firms, partnerships, and individuals comprising the independent segment of the oil industry.

Future of the Independent

Despite the important contribution the independent has made to the American economy, events since the end of World War II point clearly to the possibility of his extinction.

In many ways, he's a rough, tough, two-fisted character.



RATIO OF IMPORTS TO U.S. PRODUCTION

In other ways, he's rather delicate. For one thing, he doesn't domesticate readily.

Peculiar in the sense that he lives only in certain economic climates, the wildcatting independent will perish in an atmosphere of bureaucratic controls.

Majors Can't do the Job

Without the independent, we would be left with a handful of major companies. While these companies have fantastic reserves in the Middle East, these reserves could be lost overnight in the case of war with Soviet Russia. The United States would find itself once more in the embarrassing position of becoming more dependent upon our own oil instead of foreign supplies, but in no position to take up the slack since wildcatting would have dwindled away to nothing.

This may read like scare-talk, but it isn't intended to. Any one familiar with the major oil companies cannot help but realize that they must register maximum profits to justify the investments of their thousands of stockholders. They are therefore governed by one overriding consideration: To show a profit for their stockholders. Furthermore, because most people who invest in corporations do so as a long-term matter rather than with the thought of quick wealth, major oil companies must gage their own investments so that no phase of the business can seriously injure the whole in times of rough sledding.

What all of this means, of course, is that the major oil companies — though possessing greater capital ability — cannot embark on uninterrupted programs of wildcat drilling. Thus, the small independent is looked to for the bulk of the hazardous drilling and other activities which accompany wildcatting.

Consider the long-term economics of wildcatting, remembering that the shoe-string independent operator accounts for the great majority of wildcat wells. Between 1859 and 1956, more than $120 billion was invested in the discovery and

THE AUTHOR

A. E. Herrmann, president of Texas Independent Producers and Royalty Owners, attended a teachers college at Liberty, West Virginia. After service in World War I, he moved to Ranger, Texas, in 1919 and took a job dressing tools for a brother, the late A. C. Herrmann, who was a drilling contractor. He later bought a partnership and after A. C. Herrmann was killed in an automoblie accident in 1923, another brother, G. C. Herrmann, became a partner and remained active until 1951, when the business was sold. In 1955 he formed the A. E. Herrmann Corporation and purchased a group of properties which he operates today.

production of oil. Value at the wellhead of total crude produced during this period came to slightly less than $90 billion.

With each passing year, the cost of finding and producing oil becomes greater. Bearing this out are the findings of a cost study made recently by the American Petroleum Institute, the Independent Petroleum Association of America, and the Mid-Continent Oil & Gas Association: On a per barrel basis of net crude oil produced, these costs averaged $1.47 in 1944, $2.21 in 1948 and $3.16 in 1953.

Overall this means that it cost $2.1 billion to find 1,677,904,000 bbl of oil in 1944 as compared with $6.4 billion to find 2,357,082,000 bbl in 1953.

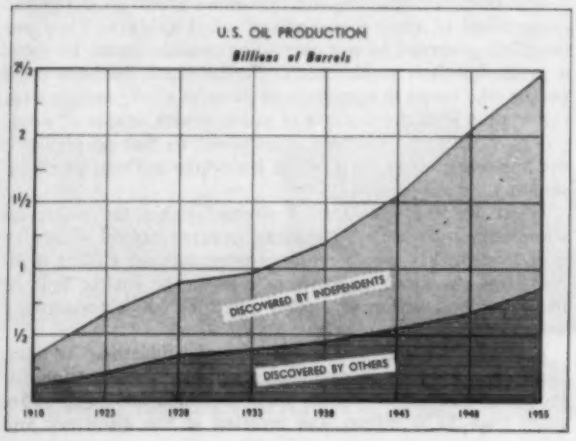
For the independent, these rising costs must be borne out of money earned from one source — the sale of crude oil. He has no income from the sale of gasoline or other products.

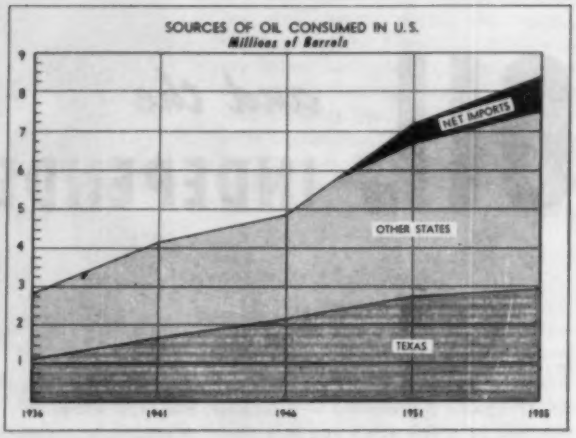
Why Take the Risk?

Why, a person might logically ask, would an independent oil producer, operating on a slim margin, risk great amounts of money on uncertain ventures? The answer would be in the form of another question: Why do people bet on horses?

Each independent operator who undertakes the drilling of a wildcat well does so in the belief that he knows something that will make him the happy recipient of Dame Fortune's smile. Therein lies the explanation for the restless shifting within the ranks of independents: A man is a successful independent oil operator today, a penniless lease-peddling promoter tomorrow.

Throughout the country today, there are more than 500,000 producing oil wells, scattered among 4000 fields. It is safe to say that there were about 10 wells drilled which gave up nothing but heartbreak for each one of these producing fields. The profit from the tenth had to be enough to keep free men drilling. Had the entire operation been centralized under one organization or one person, the business long ago would have been abandoned as unprofitable.





Government Controls Not the Answer

If major companies cannot afford to play the role of the independent in wildcatting operations, what about Government control of the industry?

Well, nearly 100 years ago, Col. Edwin Drake launched drilling for oil as a business by sinking a bit 69½ ft into the ground in Pennsylvania — a far cry, incidentally, from a well completed recently in Louisiana by a Houston independent operator which is today producing oil from sands approximately 22,000 ft deep. It is simultaneously the world's deepest well and the deepest producer.

Almost from the moment Colonel Drake completed his little producer, responsible government officials have bemoaned the "fact" that the nation is "running out of oil."

Some 52.6 billion barrels later — of which 18.8 billions came from Texas wells — we find we have 29.5 billions in reserve. And known reserves continue to increase. To be sure, they continue at a slow rate, but only because the economy in which oilmen must operate is not really a free one.

The prophets of doom have been declaring unequivocally that our oil supply nears exhaustion, particularly since 1919 when such a statement was made by the chief of the U.S. Geological Survey.

These same government planners, upon whom some would stake America's future, would have had us relying on substitute (and, in many cases, inferior) fuels from the birth of the industry. Today, they still try to induce taxpayers to subsidize synthetic processes, as witness a recent scheme to manufacture gas from alcohol.

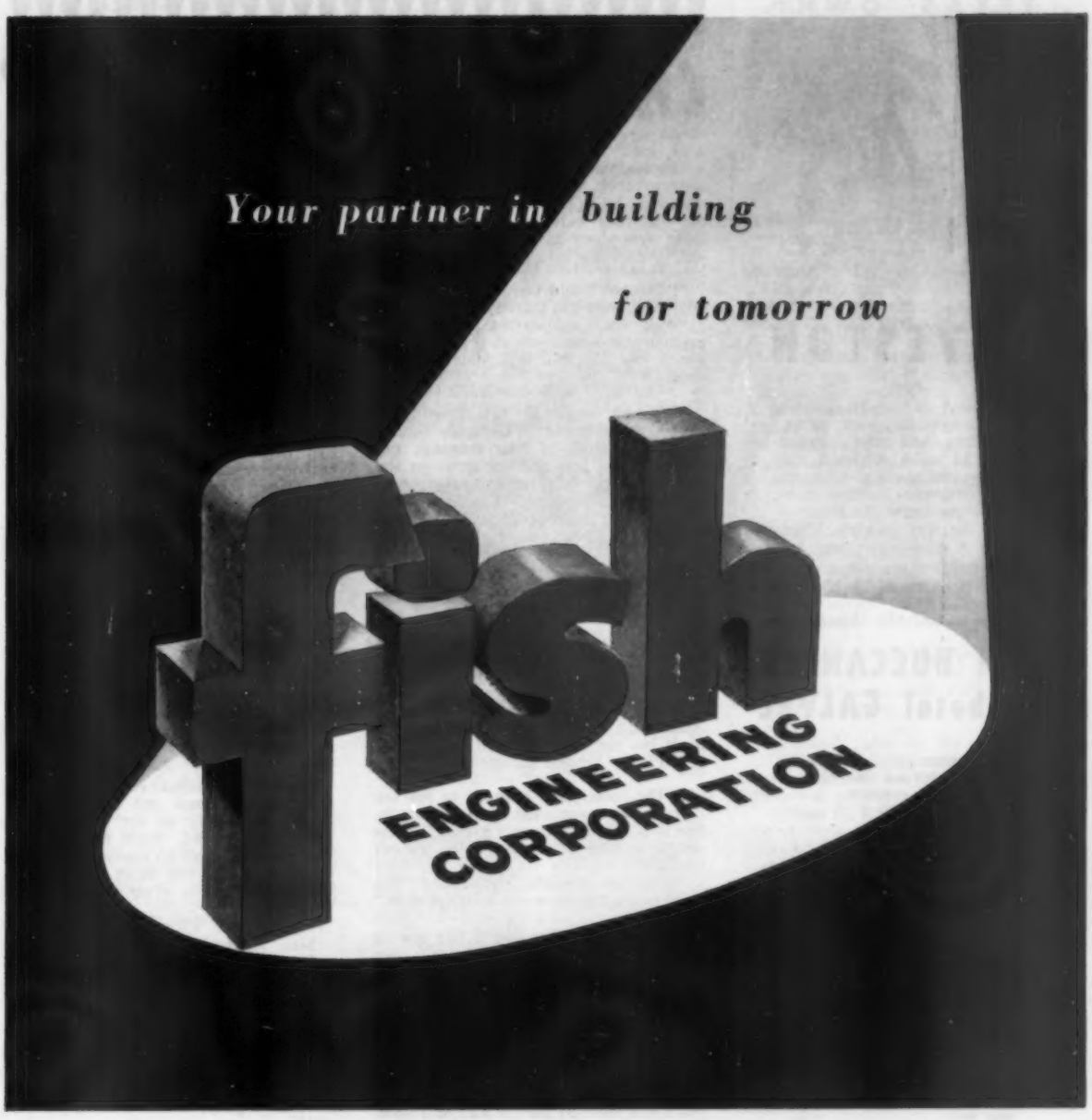
Independent a Vital Cog

The role of the independent has been more than that of explorer. In addition to accounting for the finding of vast quantities of oil, men like the Dunn brothers of Ohio originated the restoration of pressure in oil sands; Charles Roeser of Fort Worth pioneered the maintenance of reservoir pressure; and independents — particularly in the West Central area of Texas — have taken the lead in increasing recovery through water injection.

This, then, is the role of the independent. In his search for the elusive pot of gold at the end of the rainbow, he has failed more often than he has succeeded; but in his search for personal profit he has created a national wealth.

Our very freedom rests upon his achievements. We have been able to wage wars on foreign shores because he didn't know there were some things he couldn't do, so he went ahead and did them.

Whatever may be the virtues and vices of the independent, there is no evidence that government planning would mean a greater industry or that the oil business would do better if concentrated in the hands of a few large companies. ★ ★



fish
ENGINEERING
CORPORATION
HOUSTON, TEXAS

If you are considering new facilities in the oil, gas, chemical or allied industries, you can get valuable assistance from Fish Engineering Corporation and subsidiary companies. At Fish, you will find some of the finest economists, engineers and construction men in the world. They are ready to work with you every step of the way from feasibility studies through engineering, financing, construction and operation.

HOUSTON, TEXAS

Fish Service & Management Corp. • *Fish Northwest Constructors, Inc.*

GALVESTON

A sparkling isle in the Gulf of Mexico, sprinkled with palms, oleanders, and other tropical plants. 32 miles of beach and sparkling surf to enjoy. All sports and entertainment facilities. Fishing is tops—night life bright—perfect for your vacation. Write today for color folder and full information.

Your hosts on the beach are

hotel BUCCANEER and hotel GALVEZ

- SWIMMING POOL
- COMPLETELY AIR CONDITIONED
- TELEVISION — RADIO
- SUPERB SEAFOOD

AFFILIATED NATIONAL HOTELS

ALABAMA
HOTEL ADMIRAL SEMMES ..... Mobile
HOTEL THOMAS JEFFERSON ..... Birmingham
DISTRICT OF COLUMBIA
HOTEL WASHINGTON ..... Washington
INDIANA
HOTEL CLAYPOOL ..... Indianapolis
LOUISIANA
JUNG HOTEL ..... New Orleans
HOTEL DESOTO ..... New Orleans
NEBRASKA
HOTEL PAXTON ..... Omaha
NEW MEXICO
HOTEL CLOVIS ..... Clovis
SOUTH CAROLINA
HOTEL WADE HAMPTON ..... Columbia
TEXAS
HOTEL STEPHEN F. AUSTIN ..... Austin
HOTEL BROWNWOOD ..... Brownwood
HOTEL BAKER ..... Dallas
HOTEL TRAVIS ..... Dallas
HOTEL CORTEZ ..... El Paso
HOTEL BUCCANEER ..... Galveston
HOTEL GALVEZ ..... Galveston
HOTEL JEAN LAFITTE ..... Galveston
CORONADO COURTS ..... Galveston
HOTEL PLAZA ..... Laredo
HOTEL LUBBOCK ..... Lubbock
HOTEL FALLS ..... Marlin
HOTEL CACTUS ..... San Angelo
HOTEL MENGER ..... San Antonio
ANGELES COURTS ..... San Antonio
VIRGINIA
HOTEL MOUNTAIN LAKE ..... Mountain Lake
HOTEL MONTICELLO ..... Norfolk

TELEPHONE
NEW YORK—Murray Hill 6-6990
CHICAGO—Mohawk 4-5100
WASHINGTON—Executive 3-0401
MEXICO CITY—10-4600
GALVESTON—5-8536
CLEVELAND—Prospect 1-7337

AFFILIATED NATIONAL HOTELS

LAUGH with BARNEY

The newlyweds boarded the train at the start of their honeymoon. The embarrassed groom tipped the porter not to let out that they were just married. Everything went along fine for an hour or two and then laughter and pandemonium broke out.

"I thought I told you not to tell these people we were just married."

"Well, suh," replied the porter. "One genman asked me if you all is jes married, and I told him no, that you all is jes chums."

* * *

A young American girl traveling in Europe found herself in Germany, unable to speak a word of their language and feeling rather lost and unhappy. As she crossed a street she sneezed and the policeman said, "Gesundheit!" The girl turned, threw her arms about his neck and cried happily, "Oh, you can speak English!"

* * *

The average girl needs more beauty than brains because the average man can see better than he can think.

* * *

A small boy is something that stands half way between an adult and a television screen.

* * *

A customer commented: "It's every American's duty to support his government but not necessarily in the style in which it has become accustomed."

* * *

The father was listening to his son describe the many exciting things that he had done while at summer camp. "I guess you were homesick occasionally, weren't you son?"

"Well, not 'specially," he replied. "But some of the fellows were—that had dogs."

* * *

Proud Owner: Our dog is like one of the family!

Nextdoor Neighbor: Which one?

* * *

A traveling businessman boarded the Pullman and pulled back the curtains of his berth. He was astounded to find two buxom blondes reposing there. After checking his ticket to make sure he wasn't wrong, he said: "I'm deeply sorry ladies, but I'm a married man, a man of respect and standing in my community. I could not afford to have any breath of scandal touch me. I'm sorry—but one of you will have to leave."

* * *

Women can keep a secret just as well as men, but it generally takes more of them to do it. —*The Pipe Line.*

* * *

The foreman of a roustabout gang wishing to prolong the job, instructed his men to do some stalling. One day he was hailed by one of the laborers who said:

"Boss, I dug this hole where you told me to and began to put the dirt back as I was supposed to, but all the dirt won't go back in. What'll I do?"

For a long time, the foreman pondered the problem.

"There is only one thing to do," he finally announced.

"You'll have to dig the hole a little deeper."

After a shipwreck, a doctor, a parson and a lawyer found themselves in a rowboat without oars. They came in sight of an island, but their only hope of landing was for someone to go over the side and tow the boat to land through the shark infested sea.

Lots were drawn, and it fell to the lawyer. When he slipped over the side the sharks divided, and made an avenue for him.

"An answer to prayer," said the parson.

"Oh, no, just professional courtesy," commented the doctor.

* * *

"Young man," said the old married man to a friend about to be wed, "you will find as you give things to your wife, she will go through three stages."

"Really?" rejoined the lovesick swain. "That's very interesting. What are the three stages?"

"At first," came the solemn explanation, "she will say, 'You are the dearest, sweetest, most wonderful husband in the world.' Then, before you know it, you will find her accepting a gift with: 'Well, it's about time. I thought you'd never get it for me!' "

And the third stage?" the young man inquired fearfully.

The old man sighed. "Then she'll say, only to herself, 'He gave it to me without a struggle. I wonder what he's up to?' "

* * *

A newly-rich woman returned from her first trip to France and was making it known as widely as she could. "And Paris," she gushed, "Paris is marvelous. The people are all so educated and cultured; nothing crude as in this country. My dear, even the street cleaners speak French!"

* * *

Stan: Anybody hurt in the wreck?

Fran: One gentleman, I believe.

Stan: Broken bones?

Fran: Heart, I think. He sat down by his leaking suitcase and shed tears.

* * *

The old gentleman stopped to talk to the little girl making mud pies on the sidewalk.

"You're pretty dirty, aren't you, little girl?"

"Yes," she smiled, "but I'm prettier clean."

* * *

Sign on back of glass truck: "Honk your horn and I'll move my glass over."

* * *

Contract bridge is a good game when the partnership bidding runs smoothly. But one night, at a friendly game between two married couples, something went slightly wrong.

"I can't imagine," said one wife to her husband, "what you bid no-trumps on when I had three aces and four kings."

"Well, if you really must know," admitted the husband, "I bid on one queen, two jacks and three highballs."

* * *

A ministry student named Fiddle,
Refused to accept his degree
He said, "It's enough to be Fiddle,
Without being Fiddle, D.D."

PERSONALS

Martin A. Row has been named southwest division general attorney for Sun Oil Company, succeeding **John W. Timmins,** who moves to the newly created position of special counsel to the production

J. W. Timmins

M. A. Row

department. Timmins has been a Sun attorney for almost 37 years and division general attorney since 1942. Row has been in the legal department for almost 26 years.

Edwin M. Cage, senior attorney since 1954, succeeds Row as assistant division attorney. **W. Hughes Knight,** also senior attorney since 1954 and with Sun for 20 years, has retired.

Sam B. Becker and **Everett A. Johnson** were appointed senior patent attorneys in the development and patent department at the Chicago office of Standard Oil Company (Indiana).

Becker, with Standard since 1937, is inventor and co-inventor of processes which hold 11 U. S. and two foreign patents. Johnson, with Standard since 1940, holds 35 U. S. and foreign patents.

C. D. Mims, vice president in charge of production for the California Standard Company, was named vice president in charge of production and a director of the Standard Oil Company of Texas. With Standard since 1946, Mims is succeeded by **L. A. Swanson,** formerly chief engineer.

R. C. Frederick has rejoined Gulf Oil in the planning and economics department, coming from Pacific Northwest Pipe Line Corporation where he was vice president. Previously Frederick served Gulf for 28 years. He was coordinator, gas and gas liquids, for the production department when he left the company.

James P. McClurkin was named assistant to the general superintendent of Mid-Valley Pipeline Company. Formerly he was station foreman at Abbeville Station, Oxford, Mississippi, and also handled special operational assignments.

W. T. Askew

Wilburn T. Askew is the new president of Sun Oil Company, Ltd., of Canada. Until recently manager of the parent Sun Oil Company's Marcus Hook refinery, he succeeds **Joseph N. Pew, Jr.**

The first resident president of Sun Oil Company, Ltd., Askew has been associated with Sun Oil for 25 years.

Adrian L. Flint, supervising auditor at Beaumont, Texas, for Sun, was named supervising auditor to succeed **H. H. Boyer,** who retired after 37 years of service.

James A. Kincaid and **G. A. Burleson** were appointed to assist Flint. Boyer joined Sun as an auditor in 1919. Flint joined Sun in 1923 and has been supervising auditor at Beaumont since June 1940. Kincaid and Burleson have been with Sun since 1937 and 1933, respectively.

Charles E. Simons, executive vice president of Texas Mid-Continent Oil & Gas Association, has been named president of Texas Trade Association Executives.

Clarence O. Krueger was promoted from personnel assistant for Sohio Petroleum at Oklahoma City, Oklahoma, to Gulf Coast division industrial relations assistant at Houston, Texas.

C. A. Perlitz

Chas. A. Perlitz, Jr., senior vice president and director of Continental Oil Company, was elected executive vice president. He joined Continental in 1946 as general attorney and became vice president in 1953. He is also a director of several Conoco subsidiary or affiliated companies.

Harold G. Osborn, vice president in charge of manufacturing, Ponca City, and **A. W. Tarkington,** vice president and

H. G. Osborn

A. W. Tarkington

regional general manager, Fort Worth, were promoted to senior vice presidents, Houston.

R. L. Bosworth, treasurer, advanced to vice president, coordinator of company activities at Ponca City, Oklahoma, and assistant treasurer; **L. C. Peters,** financial vice president, is now financial vice president and treasurer. **G. T. Pearson,** director of organization planning, Houston, went to Fort Worth as regional general manager.

E. D. McElvain was promoted to manager of Phillips Petroleum Company's Washington, D. C. office, replacing **R. C. Jopling,** vice president, who retired. **C. D. Whitfield,** assistant to Jopling will replace McElvain as director of the natural gas department's industrial development division at Bartlesville, Oklahoma.

Retiring after almost 30 years of Phillips service, Jopling plans to continue his office in Washington.

C. Eugene Davis, petroleum consultant, and recently retired vice president of Shell Oil Company, is to serve as general secretary of the Fifth World Petroleum Congress to be held in New York, 1959.

C. E. Davis

At the Fourth Congress in Rome last summer, **Eger V. Murphree,** president of Esso Research and Engineering Company, was re-elected chairman of the organization's top governing group, the Permanent Council.

A general organizing committee set up to conduct the Fifth Congress includes: **F. S. Clulow,** Shell Oil Company; **H. W. Field,** Atlantic Refining Company; **Jerry McAfee,** Gulf Oil Company; **John C. Zimmer,** Socony-Mobil Laboratories; **E. B. McConnell,** Standard Oil Company (Ohio); **H. B. Nichols,** California-Texas Oil Company; **J. K. Roberts,** Standard Oil Company (Indiana); **W. C. Kinsolving,** Sun Pipeline Company, and Murphree, chairman.

Arthur M. Sherwood is the new secretary of Socony Mobil Oil Company, Inc. Formerly assistant secretary, he succeeds **William D. Bickham,** retired after 27 years of service. Also retiring after 29 years is **Paul J. Buttles,** an assistant secretary.

Theresa Jean Lutz and **James J. McKay** will succeed Sherwood and Buttles. Miss Lutz, with Socony since 1929, is the first woman to become an officer of Socony Mobil.

Sherwood came to the company in 1954 from a law firm and served in Socony office of general counsel until his election as an assistant secretary.

William W. Richardson and **Warren M. Albert** were appointed assistant comptrollers of Socony. Richardson, with the company for eight years, has been secretary of the coordination committee, and Albert comes to his post from 28 years service with Magnolia Petroleum Company.

John H. Robinson Jr., was appointed to the Shell Oil Company public relations staff of the Los Angeles, California office. Previously he served as publicist for Citizens National Trust & Savings Bank of Riverside, California, and spent 14 months at Supreme Headquarters Allied Powers Europe as an Army public information specialist.

Robert L. Kidd was elected president, of Cities Service Oil Company (Delaware), succeeding **Singer B. Irelan.** To accept the new post, he resigned as president of the Arkansas Fuel Oil Corporation where he is succeeded by **J. E. Heston,** resigned vice president of Cities Service Oil Company.

R. L. Kidd

Kidd joined Cities Service in 1925 as a geologist and in 1953 he was elected president of Arkansas Fuel, Arkansas Pipeline Company and Orange State Oil Company. Heston joined Cities Service in 1930, and in 1954, transferred to Bartlesville as vice president and director of Cities Service Oil Company.

Padre Island rig gets 45,214 from one Tiger Brand

Holmes Drilling Co. Rig No. 3 on Padre Island, rigged with 2500 feet of 1¼", 6 x 19, Excelloy Preformed Monitor Improved Plow Steel Wire Rope with IWRC.

ton miles Wire Rope

"We always thought that 25,000 ton miles was as good service as could be expected from a drilling line, but this Tiger Brand line has lasted for 45,214 ton miles! That's the best service we ever had on any line." This statement comes from Charles N. Susil, tool pusher on Rig No. 3 of the Holmes Drilling Company, Houston, Texas.

The rig was drilling on Padre Island, about 25 miles from Corpus Christi, Texas. Four wells had been drilled with the one 2500 foot, 1¼", 6x19, IWRC wire rope. The rope had been on the rig about 15 months, making a total of 294 trips and 45,214 ton miles. That's good service any way you look at it!

The drilling on Padre Island was tough going. At times there were 290,000 pounds on the line for jarring and fishing, and much of the hole was drilled at an angle.

This job shows how accurate ton mile records give a much better picture of the real service you can expect from American Tiger Brand Wire Rope. You can get Tiger Brand Wire Rope from leading distributors anywhere in the oil fields.

One Tiger Brand Wire Rope drilled for a record-breaking 45,214 ton miles . . . almost double the expected life.

Charles N. Susil, tool pusher, says, "We get better service out of Tiger Brand than any wire rope we ever used."

Big diameter tie down and big sheaves contributed to Tiger Brand's long life.

The right Wire Rope will do the trick

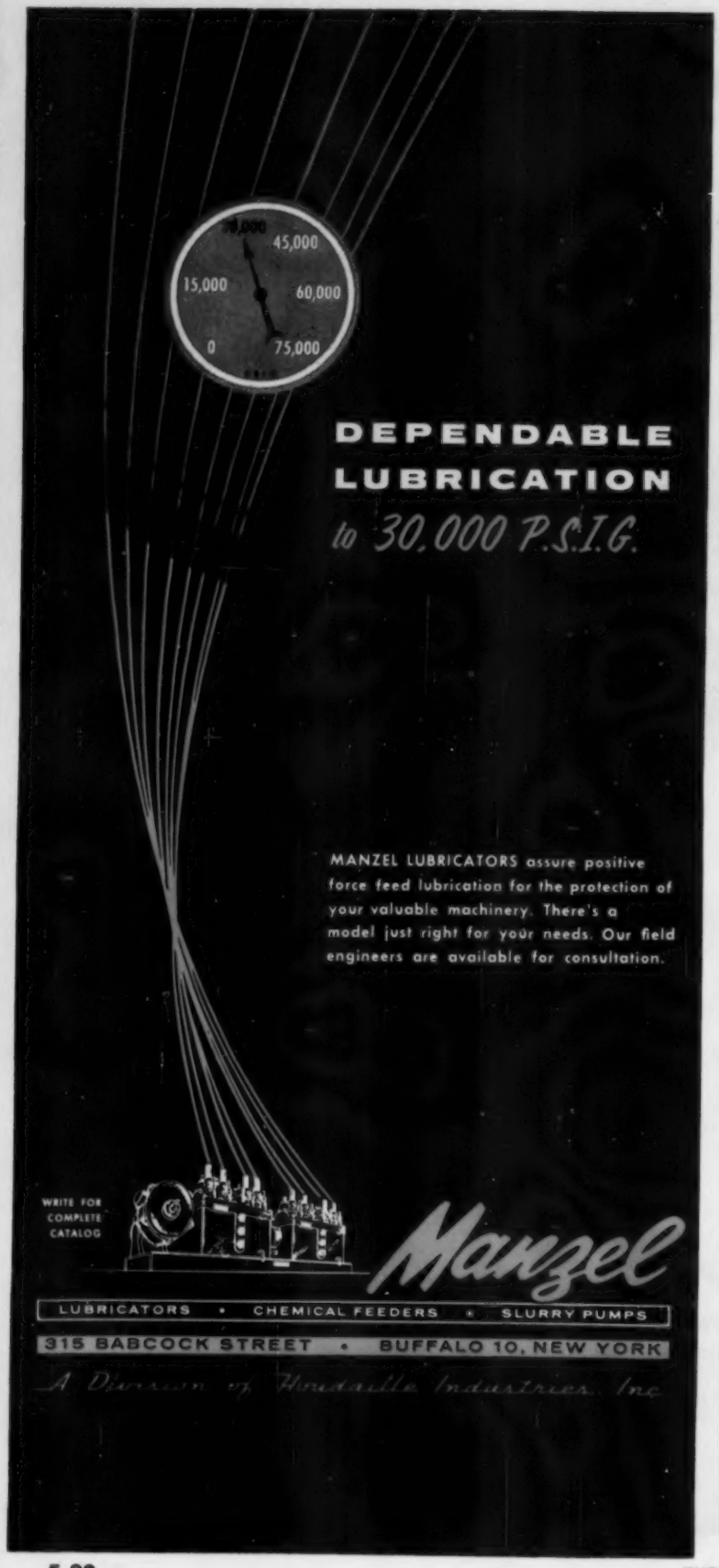
AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN TIGER BRAND WIRE ROPE

Excellay Preformed USS

UNITED STATES STEEL


45,000
15,000
60,000
0
75,000
DEPENDABLE
LUBRICATION
to 30,000 P.S.I.G.
MANZEL LUBRICATORS assure positive force feed lubrication for the protection of your valuable machinery. There's a model just right for your needs. Our field engineers are available for consultation.
WRITE FOR COMPLETE CATALOG
Manzel
LUBRICATORS • CHEMICAL FEEDERS • SLURRY PUMPS
315 BABCOCK STREET • BUFFALO 10, NEW YORK
A Division of Houdaille Industries, Inc.

▸ **William A. W. Krebs Jr.,** new vice president of Arthur D. Little, Inc., industrial research company, formerly represented the company as director and secretary of its affiliate, Nuclear Metals, Inc. He will continue as visiting associate professor at the MIT School of Industrial Management.

A. C. Long

J. W. Foley

▸ **Augustus C. Long,** president of The Texas Company, was elected chairman and chief executive officer to succeed **J. S. Leach,** who retires October 1.

James W. Foley, executive vice president, will succeed Long. Leach, who completed 40 years with Texas, will continue as a member of the company's board of directors.

DEATHS

▸ **R. B. "Reid" Grainger** . . . of Ojai, California, and a 34-year Byron Jackson Oil Tools representative, died June 10.

▸ **W. C. "Bing" Meeks** . . . 75, representative of The S. M. Jones Company at Wichita, Kansas, for the past 30 years, died there June 7.

▸ **Dr. James J. Lang** . . . 39, development engineer, and **Donald K. McBain** . . . 52, project engineer, The Fluor Corporation, Ltd., lost their lives in the collision of two commercial airliners at Grand Canyon, Arizona, June 30.

▸ **Marshall L. Noel** . . . 50, president of the Frantz Tractor Company, Inc., was killed in the Venezuelan Super-Constellation airliner crash off the New Jersey coast, June 20.

In the construction machinery field since 1928, Noel was previously vice president and general sales manager of the Allis-Chalmers tractor division.

▸ **Ralph Neuhaus** . . . vice president of Associated Oil & Gas Company and general manager of Associated Oil Field Rentals, died at his home in Houston, Texas, June 16 after a brief illness. With Associated since 1953, he was previously vice president and general manager of Hughes Tool Company.

▸ **Joseph J. Curvin** . . . 53, purchasing agent for United Gas Corporation, died May 13 in Shreveport, Louisiana, following a month's illness. With United Gas for 20 years, he was appointed purchasing agent in 1950.

▸ **H. H. Brereton** . . . 62, comptroller of The California Oil Company, died June 10 in Woodbridge, New Jersey. He joined California in 1945 and was appointed comptroller in 1952.

▸ **A. B. Haynes** . . . field superintendent for O. R. Burden Construction Corporation, died in Dallas, Texas, on June 16.

Right from the start . . .

FAST

POWERFUL

AMERICAN BOSCH
MAGNETOS

Fast, powerful — that's the power-packed story of American Bosch Magnetos — today's finest ignition units for oil industry engines. Many advanced features give these famous Magnetos greater power for split-second starting, PLUS the built-in stamina that assures years of constant, trouble-free operation in Drilling, Producing, Pipe Line and Refinery service. That's why they're so widely used as original equipment by so many leading engine builders.

For your every replacement need, there's an American Bosch Magneto precisely engineered for maximum efficiency at all engine operating speeds and loads. Moreover, American Bosch can serve you well with all the advantages of one of the world's largest and most efficient Service organizations. There's an AB Service Agency near you. Write today for application data on your high or low tension ignition engines. American Bosch, Springfield 7, Mass. A Division of American Bosch Arma Corporation.

FOR OIL INDUSTRY
HIGH & LOW TENSION
SPARK IGNITED
ENGINES

In drilling rigs, oil pumping stations, pipeline operations and gas-engine driven compressors . . . wherever they are in service in oil industry engines, American Bosch Magnetos and Pulse Generators deliver consistently dependable performance in month-after-month of continuous operation.

AMERICAN BOSCH

She 'Logs' Them

Pauline Peterson

Twenty-eight years ago this October, Pauline Peterson sat down at her first Phillips Petroleum Company desk. The work-battered desk was in the outer offices at Russell, Kansas. Four years later the offices were moved to Wichita, Kansas. Just recently they moved into the Rule Building in Wichita where Pauley now occupies a charming rose-tinted office.

The desk may have a higher polish but it is still littered with piles of oil-well information, all of which has held a steadily concentrated interest for her. Through the years each new well plots its own story, different and exciting. Pauley "logs" them. Over 60,000 logs have been filed away. The routine, she says, is never dull.

Outside the office, Pauline works actively for Wichita Civic Music and she finds the Pilot Club International stimulating; she enjoys the Jane Phillips Club and is an enthusiastic member of the Wichita Oil Secretaries. For hobbies she chooses records, vacations and friends.

A Valuable Asset

Around The Ohio Oil Company in Casper, Wyoming, Margaret Stigall is considered "a valuable asset" — so say fellow employees. As secretary to the division landman, Margaret has proved to be one upon whom the boss can always depend and who attends to everything when he is out of town.

Originally from South Dakota, she attended schools in Casper and began her employment with an insurance firm. Her next step up took her to the state capitol as chief clerk in the state health department. In 1944, Margaret, now Mrs. Harry E. Stigall, returned to Casper and began her oil career with Ohio Oil.

Margaret Stigall

Active in the National Secretaries Association, she is a charter member of the Casper Desk and Derrick Club. She reports, however, that her biggest interest in the last few years has been her husband, Harry, and their new home. Together they spend any spare time on fishing and hunting excursions, or with Margaret's 10 nieces and nephews, all of Casper.

SIMPLYTROL AUTOMATIC PYROMETER

Cat. No. 4531 0/2500° F
Price $132.00

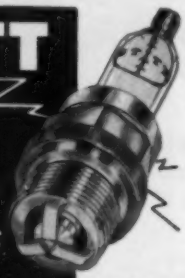
Thermocouple type Automatic Pyrometer for controlling temperature in furnaces, ovens, and processes. The Simplytrol is economical and reliable with few moving parts. There are no vacuum tubes. The regular load relay is S.P.D.T. 5 Amps. Optional heavy duty relays to 40 Amps.

10 temperature ranges cover from —75° to 3000° F. Several special ranges to —400° F. "On & Off" control for holding the desired temperature works on gas, oil or electric heat. Indicating meter-relay is medium high resistance and has bimetal cold junction compensation. For use with all standard thermocouples. Accuracy 2%.

"Auto-Limit" switch changes Simplytrol from automatic controller to limit pyrometer for safety shut down or warning. Cabinet: 6½x 6½x9½ inches. Also flush panel mount models. Send for new Bulletin G-7 for more data. Assembly Products, Inc., Chesterland 48, Ohio.

(West Coast: Desert Hot Spring 48, Calif.)
See Us at WESCON Show, Aug. 21-24, Los Angeles.

STITT NEW triple ignitor SPARK PLUGS



INCREASE MAGNETO LIFE

Save on costly magneto overhauls—cut engine "down" time substantially. Stitts last up to 10 times longer—require fewer changes—reduce wear. It's not the plug price, but the "change cost" that's important. Stitts cost a little more—save hundreds of dollars per engine per year. Factory equipment in Clark, Cooper-Bessemer, Worthington, other leading engines.

Write for Field Test Reports
Free $1 Gap Gauge

STITT Ignition Company
Columbus 1, Ohio

Get STITTS From:

BELL ENGINE SERVICE	JNO. MULLER CO.
BETHLEHEM SUPPLY CO.	REAGAN EQUIPMENT CO.
CLARK BROS. CO.	WAUKESHA ENGINE & EQPT. CO.
COOPER-BESSEMER CORP.	WAUKESHA-PACIFIC
HOPEMAN EQUIPMENT CO.	WAUKESHA SALES & SERVICE Inc.
INGERSOLL-RAND CO.	WORTHINGTON CORP.

MAGNETO IGNITION SERVICE R. ANGUS (ALBERTA) Ltd. CANA
. . . and Supply Stores Everywhere.

BrakeSol

ELIMINATES COSTLY PARAFFIN REMOVAL METHODS

HOLDS PARAFFIN IN SUSPENSION from FORMATION to REFINERY

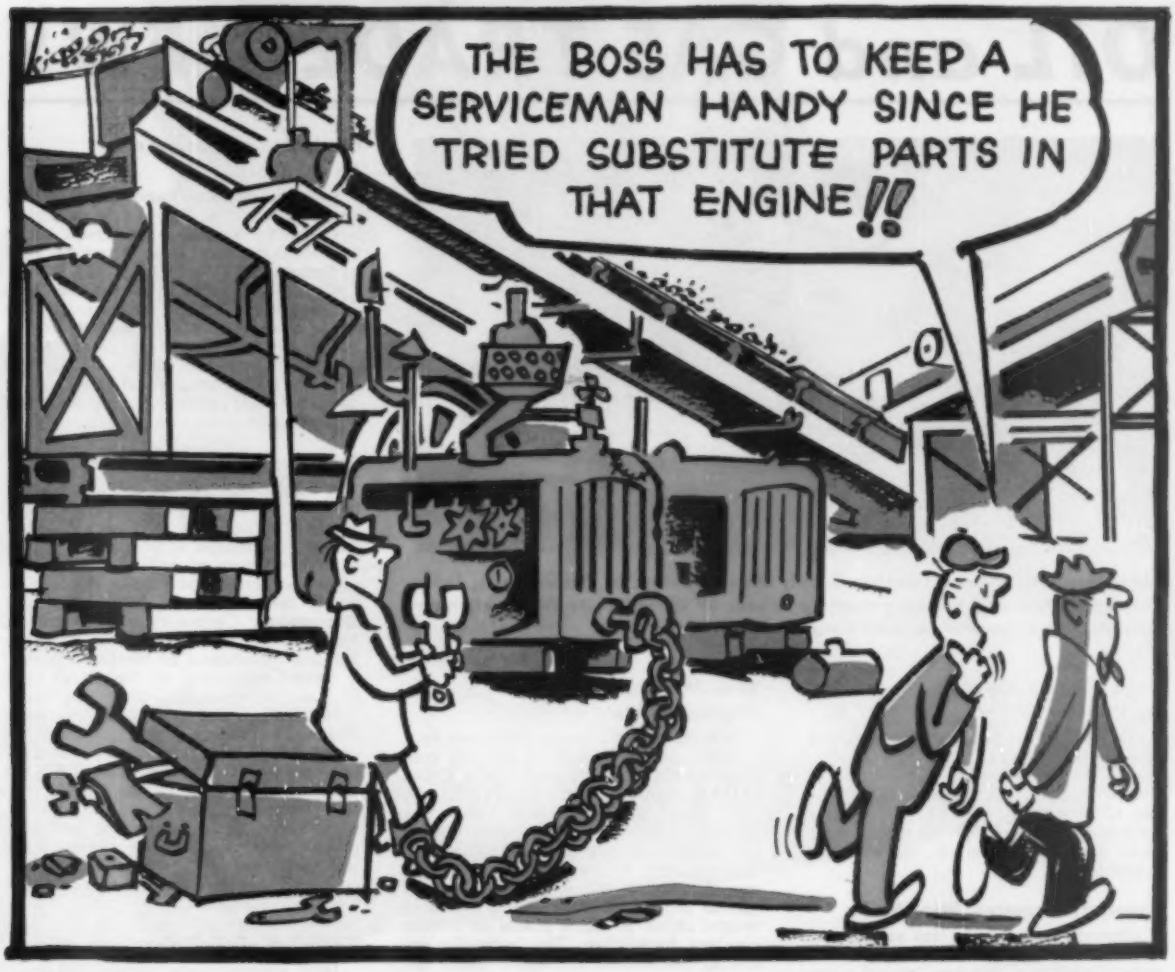
BRAKESOL is economical and safe to use, prevents and removes paraffin from the tubing, flow lines, tank bottoms and pipe lines. Effective on both asphalt and mixed-base paraffin.

FOR SERVICE CONTACT YOUR NEAREST BRAKESOL SALES ENGINEER

—EXPORT DISTRIBUTOR—
The National Supply Co.
Export Division

CARMI, ILLINOIS 4-2905
CASPER, WYOMING 2-3453
ELLINWOOD, KANSAS 537-R
FT. MORGAN, COLO. UNderhill 7-5981
HOUSTON, TEXAS HOmestead 5-6648
LOVINGTON, NEW MEXICO 6-5954
NEW IBERIA, LOUISIANA EMerson 9-3498
ODESSA, TEXAS 2-2575 7-7192
OKLAHOMA CITY, OKLA. VI 3-6629 WH 9-5561

BRAKESOL, Inc.
P.O. Box 9506 Okla. City, Okla.



Ever get fooled on "look-alikes"?

Take a part like your lube oil filter element. There may be substitutes that *look* like Caterpillar originals. But remember: CAT* elements filter every drop of oil before it reaches moving parts. They remove harmful particles, but they do *not* remove beneficial oil additives. And their special plastic-impregnated filtering material (accordion pleated to increase working surface) functions effectively through an entire oil change period. You're sure of longer engine life—less down time.

With substitute parts, can you be sure of anything?

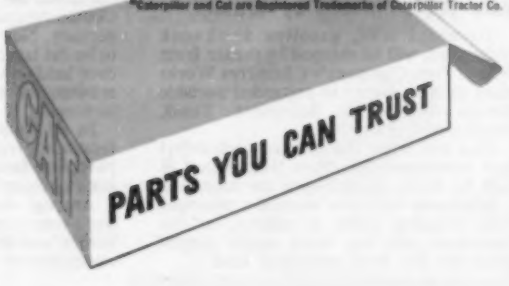
Better see your Caterpillar Dealer's Parts Representative—and get Cat original parts every time.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

Cat lube oil filter elements are specifically matched to the requirements of Caterpillar Engines. Don't buy trouble — buy factory-tested, job-proven Cat filters. They *really* protect your engine.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



OIL and GAS TRADE NEWS

New home of Jones & Laughlin Supply Division's store at Wichita Falls, Texas. This brick, steel and masonry structure houses an office, a completely equipped Axelson pump repair shop, and a warehouse.

Supply Store Opens in Venezuela

Mid-Continent Supply Company announces the opening of a new store at Anaco, Venezuela.

Store manager in Anaco is G. S. Durbin. Other personnel include J. E. Weems, field salesman; W. P. Brandon, head storeman, and A. J. Covaleski, stock control supervisor.

Crescent Acquires Win-Well

Crescent Corporation has acquired all the assets of Win-Well, Inc., of Los Angeles, California, and has formed a new corporation to be known as Win-Well Manufacturing Company, to manufacture and market the Win-Well 7-way multiport rotary selector valve.

This Win-Well valve is designed for manual operation or automation, to eliminate complicated manifold systems in producing fields by bringing the product of as many as seven pipe lines to a central source for sampling, metering and testing.

Officers of the new company are William H. Garbade, chairman of the board; William B. Pollock, president; Ross Bolton, vice president; W. F. Styler Jr., vice president and treasurer, and O. O. Kerr, secretary. Garbade, Bolton, Styler, and Kerr are all officials of the Crescent Corporation, and Pollock was president of Win-Well, Inc. Headquarters will be in Los Angeles.

Bulk TEL Shipment by Water

Tetraethyl lead, gasoline antiknock compound, will be shipped by tanker from the Du Pont Company's Chambers Works plant in New Jersey to expanded portside storage facilities at Beaumont, Texas, starting early in 1957.

This will mark the first time tetraethyl lead compound has been transported in bulk by water, according to the company.

Beaumont will thus become a principal TEL shipping point to refiners in the Southwest and the third major supply point for Du Pont tetraethyl lead.

W-K-M Permanent Display Valve

W-K-M Manufacturing Company, Inc., recently opened its new 12-acre, air conditioned plant at Missouri City, Texas, near Houston.

A 30-in. pipe line show valve was erected to serve as a permanent display piece in front of the new plant. The valve is a standard weld-end 30-in. series 600 pipe line valve and is equipped with a special piston operator. Entire assembly weighs 24,000 lb and is placed on a thick concrete foundation. The hydraulic operating mechanism, concealed within the valve body, is operated from a remote point in the plant.

W-K-M is a subsidiary of ACF Industries.

New BJ Sales, Service Company

Sales and service operations for Byron Jackson oil tools and PB products will now be handled under the name of Byron Jackson Tools, Inc., a new addition to the Byron Jackson group in Borg-Warner Corporation.

Byron Jackson Tools will maintain the same policies, personnel, and locations with which Byron Jackson customers are already familiar.

G-E Holds Gas Turbine Lectures

More than 70 representatives of government and business concerns throughout the world met in June at General Electric Company's gas turbine department, Schenectady, New York, for what is believed to be the largest industrial lecture program ever held in the United States on the operation, theory, and maintenance of gas turbines.

In addition to classroom lectures, the representatives toured the gas turbine department factory to see units in various stages of construction and test.

Among those attending the meeting were representatives from three oil companies and five natural gas transmission companies.

Clark Takes Compressor on Tour

When the customer cannot come to you, go to the customer. This simple sales principle was followed in what turned out to be something unusual in heavy oil field equipment annals.

Clark Bros. Company, one of the Dresser Industries, recently completed a tour of key cities in Kansas, Oklahoma, Louisiana, Texas, and New Mexico with its new packaged compressor for oil and gas field use. The heavy unit, which is actually a completely self-contained compressor station, was transported on a truck.

Shipyard, Dresser Join Forces

A major shipyard and a leading manufacturer of oil well drilling machinery have joined forces for "packaged" production of specialized ships needed by the nation's offshore oil industry.

Teamed in this venture — believed to be the first of its kind — are New York Shipbuilding Corporation, of Camden, New Jersey, which operates as the shipbuilding department of Merritt-Chapman & Scott Corporation of New York, and Dresser Industries, Inc., of Dallas, Texas.

Under the initial contract totaling more than $3,500,000, they will construct and completely equip two vessels — a 2500 gross-ton drilling tender and a 297 ton cargo-supply ship — for the Coastal Marine Drilling & Construction Corporation, of Houston, Texas. The ships, both self-propelled and entirely self-contained units, will operate as a highly mobile team — complete with a helicopter port atop the tender's bridge deck.

Koehring, C-R-C Combine Efforts

Joint announcement has been made by the Koehring Company and Crutcher-Rolfs-Cummings, Inc., of a combined venture to merge certain of their activities dealing with the manufacture and sale of machinery used by cross-country pipe line constructors.

Under the arrangement, Koehring acquires the designs and manufacturing rights to the C-R-C Big Incher and Middle Incher cross-country ditching machines which will be built at Newton, Iowa, by the Parsons Company, a Koehring subsidiary. C-R-C will sell the Big Incher, Middle Incher, the line of Koehring excavators, and Parsons Trenchliners.

Venezuelan Firm Interest Bought

National Lead Company has acquired a substantial interest in Baritina de Venezuela, S. A., a distributor of oil well drilling materials.

The Venezuelan firm is increasing its capital from the present $900,000 to $3,150,000 to finance construction of production facilities for materials used in drilling fluids by the expanding Venezuelan petroleum industry. These facilities are said to be the first of their kind in Venezuela, all previous drilling materials having been imported.

New facilities will include two processing plants, one on the east side of Lake Maracaibo to service petroleum producers in that area, another plant at Puerto de La Cruz to supply drillers in eastern Venezuela.

In **ALUMINUM** too

here's how to get more for your money!

Call your nearby Tube Turns' Distributor. He can fill *all* your needs in welding fittings and flanges—aluminum as well as other piping materials. He provides industry's most complete line—over 4,000 top quality items —different sizes, types, schedules, materials; hence, this one source saves you purchasing time, cuts red tape. He acts as your warehouse. He gives you prompt delivery. And through him, Tube Turns' Engineering Service gives you valuable application help. To take advantage of this cost-cutting service, specify and buy TUBE-TURN Welding Fittings and Flanges.

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS

LOUISVILLE 1, KENTUCKY

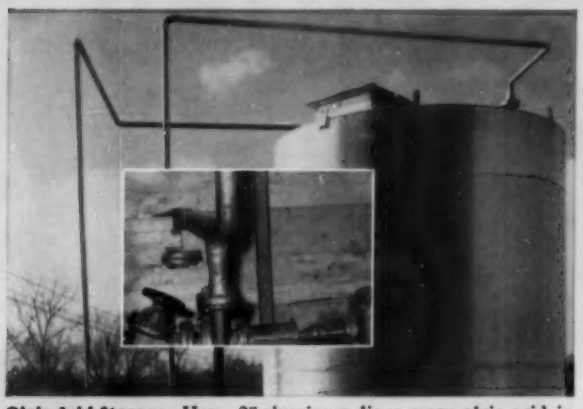
A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
Los Angeles • San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

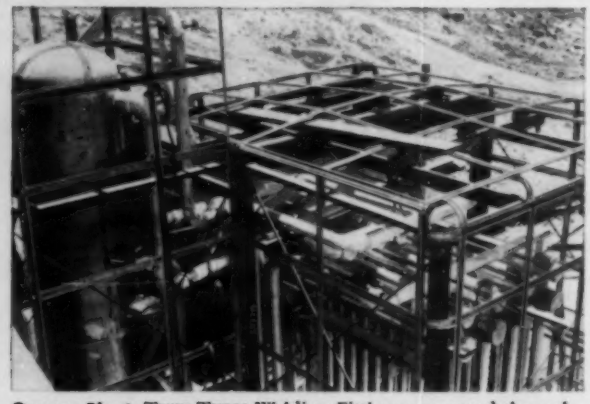
ALUMINUM PIPING

TUBE TURNS' ENGINEERING SERVICE

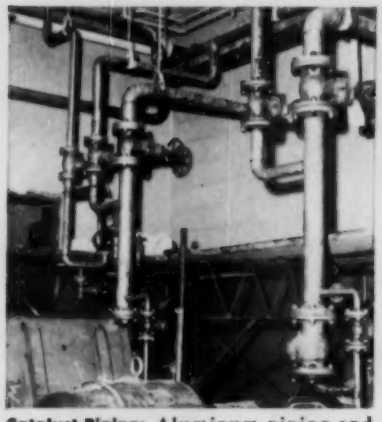
helps you apply aluminum piping on jobs like these...



Oleic Acid Storage: Here, 2" aluminum lines carry oleic acid in this installation for a rubber company. TUBE-TURN Aluminum Welding Fittings are used for directional changes. Insert shows a compact combination of these fittings at a pump . . . an elbow, tee, reducer and flange.

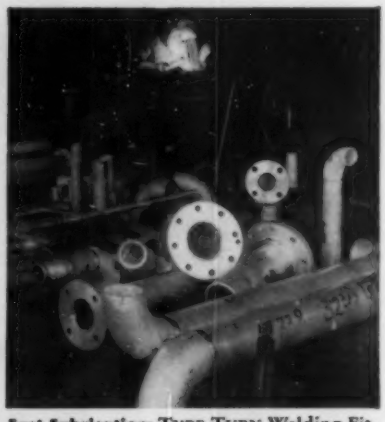


Oxygen Plant: TUBE-TURN Welding Fittings were used throughout this 25 tons-per-day oxygen plant for ore recovery. Here, operating temperatures range from 100°F to –320°F. Picture above shows reversing heat exchangers and fractionating tower prior to being enclosed in insulating shell.



Catalyst Piping: Aluminum piping and fittings were specified for certain services in this new TCR bead catalyst plant to prevent contamination of the catalyst. TUBE-TURN Welding Fittings and Flanges were employed in all aluminum lines from 1" to 10". Result: Lines are permanently leak-proof – maintenance is minimized.

Refinery Wax Coils: Originally, retubing of seven wax sweaters in a large refinery called for coils of another metal. Switch to aluminum piping and TUBE-TURN Welding Fittings saved $50,000 in material costs! Each unit required 900 TUBE-TURN 180° Welding Returns of 1" OD.



Fast Fabrication: TUBE-TURN Welding Fittings and Flanges are dimensionally accurate. Rigid inspection by Tube Turns assures true circularity and uniform wall thickness. Result: Alignment is perfect; fabrication is faster; installation simplified.

NEW BOOKLET—This new Tube Turns' catalog gives helpful information on aluminum pipe, fitting and flange materials. Mail the coupon for your free copy.

TUBE TURNS, Dept. K-4
224 East Broadway, Louisville 1, Kentucky

Please send free copy of new catalog on Aluminum Fittings and Flanges.

Company Name _____

Company Address _____

City _____ *Zone* ____ *State* _____

Your Name _____

Position _____

Available from your nearby TUBE TURNS' distributor

DISTRICT OFFICES:

New York	Los Angeles
Philadelphia	San Francisco
Pittsburgh	Seattle
Cleveland	Atlanta
Detroit	Tulsa
Chicago	Houston
Kansas City	Dallas
Denver	Midland, Texas

*"TUBE-TURN" and "TT" Reg. U. S. Pat. Off.

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

Now!
PRECISION EXPANDING MANDRELS
by CHAMPION

The expanding sleeve, mounted on tapered arbor, expands automatically to fit the hole. Inserted by hand — no arbor press needed. Always an exact, positive, concentric fit. Locked by a single mallet blow. Unlocked in the same way. CHAMPION Expanding Mandrels are used in machine shops around the world. Save time, cut production costs, whether the job calls for machining one piece or a thousand.

Precision Model has expansion range of .010". Available in regular sizes to fit holes from ½" to 9½" diam. Holds work to tolerances of .0002" run-out. Guaranteed for precision grinding, turning and milling operations.

Standard Model maintains close tolerances, handles material of any length bore, hard or soft metals — from thin tubes and bushings to heavy castings and forgings. A set of fourteen will fit every hole from ½" to 9½" diameter.

CHAMPION Expanding Mandrels can be made in special shapes and sizes to fit any specifications. Quotations on request. Write for descriptive folder today.

Certain areas are available for qualified distributors.

PATTON
MANUFACTURING COMPANY, INC.
1802 West Pleasant St., Springfield, Ohio

OVER 200
LEADING NATIONAL COMPANIES
NOW USE FRANCE RINGS

When you need Packings, Piston Rings or Valve Discs, France has over 55 years of experience that spells out:

M-A-X-I-M-U-M
P-E-R-F-O-R-M-A-N-C-E
and . . .
S-E-R-V-I-C-E

Check & SEE FOR YOURSELF!

*NAMES FURNISHED ON REQUEST

FRANCE PACKING CO.
PHILADELPHIA 15, PA.

SINCE 1898

For Full Information — Mail Coupon Now!
FRANCE PACKING CO.
PHILA. 15, PA.

Name .....
Title .....
Company .....
Address .....

Extra-Handy
...and tough all the way through!

8 sizes, ⅛" to 6" pipe.

RIDGID
the easy-to-use Bench Pipe Vise

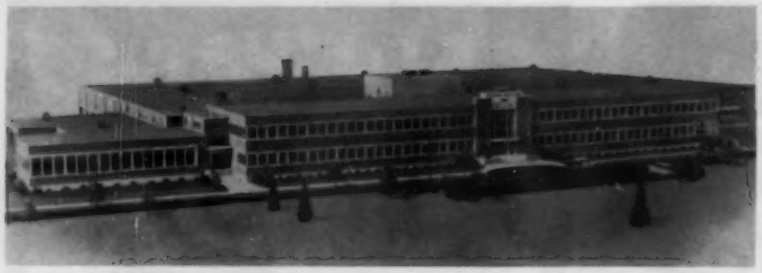
Look at the *more* you get for your money . . . built-in pipe rest aids accurate threading, handy pipe bender . . . Lon-Grip tool-steel jaws hold pipe firmly without chewing it up . . . yoke and base of special last-a-lifetime malleable . . . a bargain in quality!

Order from your Supply House today.

RIDGID Chain Bench Pipe Vise —3 sizes to 8" pipe.

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company, Elyria, Ohio, U.S.A.



Now occupying its newly erected modern brick and concrete plant and general offices in Norwood, Massachusetts, is Mason-Neilan Division of Worthington Corporation. Building comprises about 144,000 sq ft of floor space.

New Plant for Lunkenheimer

A new iron and steel valve plant of the Lunkenheimer Company, Cincinnati, Ohio, was completed recently as part of the firm's program of consolidation and expansion of all manufacturing operations.

The new structure adds more than 100,000 ft of floor space to Lunkenheimer production facilities.

New Division Headquarters

Grant Oil Tool Company and its subsidiary, MacClatchie Manufacturing Company, have recently opened new division headquarters in Odessa, Texas.

Rex Walling is division manager.

The modern combination warehouse and office building contains nearly 10,000 sq ft of floor space. The Odessa division is base headquarters for Grant and MacClatchie branches at Hobbs, New Mexico, and at Oklahoma City.

American, German Firms Combine

Contracts have been signed forming the Griscom-Russell-Schack Company, Inc., it was announced jointly by The Griscom-Russell Company, a subsidiary of General Precision Equipment Company, and the Schack Rekuperator Company, Dusseldorf, Germany.

Headquarters and main sales offices of the new firm are located in Pittsburgh, Pennsylvania. Fabrication of the recuperators will take place in the Griscom-Russell plant in Massillon, Ohio.

New District Office Opens

Opening of a new district office and field servicing station by The Western Company in Rankin, Texas, has been set for about August 1.

The new $200,000 station will serve a six-county area of the Permian Basin.

EASY TO READ
MARKINGS
THAT ARE DURABLE
DESIGNED FOR
MAXIMUM ON-THE-JOB
SERVICE
LUFKIN
CHROME CLAD
"DERRICK" TAPE
Rugged service and dependable accuracy are carefully built into this fine tape. Narrow, sturdy line, with genuine Chrome Clad finish, is rust and corrosion resistant. Rollers in frame, oversize drum, and extra long handle provide extra leverage and quick, easy rewinding. Block hook with ribbed face quickly positions tape at zero for accurate measure. These are but a few of the Lufkin features that assure maximum on-the-job service.
BUY LUFKIN TAPES • RULES • PRECISION TOOLS
FROM YOUR SUPPLY HOUSE
THE LUFKIN RULE COMPANY, Saginaw, Michigan
New York City
Barrie, Ontario
BETTER MEASURE WITH LUFKIN
390

FTC Drops Evis Complaint

On April 26, 1956, the Federal Trade Commission dismissed its complaint entered February 5, 1954, against the Evis Manufacturing Company of San Francisco, California, after more than two years of hearings.

Evis was charged with "the dissemination of numerous false advertisements of its product, Evis water conditioners, in violation of the Federal Trade Commission Act."

Hearing Examiner Abner E. Lipscomb wrote in his initial decision: ". . . we must conclude that the allegations of the complaint have not been supported by reliable, probative and substantial evidence. Accordingly, it is ordered that the complaint herein be, and the same hereby is dismissed."

SICA Head Inspects Axelson Unit

William De Ronde, president and managing director of Servicios Industriales, C.A., has recently visited the United States, where he inspected the new line of Axelson Hydrax Hydraulic Pumping Units for the oil industry.

His firm, SICA, represents the sales and service of all Axelson products for the petroleum industry in Venezuela and Colombia.

New Chemical Construction Firm

Scientific Design Company, Inc., a firm which specializes in design and engineering of chemical manufacturing plants, has formed a wholly owned subsidiary for the construction of industrial plants in the chemical field.

Name of the new firm is SD Plants, Inc. It will shortly complete its first two major projects: a polyvinyl chloride plant in Passaic, New Jersey, for the Eleonora Chemical Corporation, a subsidiary of The Pantasote Company, and a polyvinyl chloride plant in Leominster, Massachusetts, for the chemical division of The Borden Company. Both plants are scheduled to begin operation this summer.

Officers of SD Plants are Harry A. Rehnberg, president; Ralph Landau, Robert B. Egbert, and Thomas P. Brown, vice presidents.

Design Award for Tractor-Shovel

The sixth annual Industrial Design Institute Award has been presented to Jon W. Hauser, St. Charles, Illinois, for his design work on the model HH "Payloader," tractor-shovel manufactured by the Frank G. Hough Company, subsidiary of International Harvester Company.

Division Name Change Effected

Name of the components division of Servomechanisms, Inc., has been changed to the Mechatrol Division.

This action is in keeping with Servomechanisms' policy of helping to maintain a family resemblance by prefixing component division names with "Mecha."

The Mechatrol Division specializes in the fields of instrument motors, automatic controls, and instrumentation.

Pacific Mud Company Organized

Organization of Pacific Mud Company, a new firm which will distribute oil well drilling muds in the West Coast area, has been announced by Fred B. Williams, president.

Headquarters will be Los Angeles, California. The company will be distributors for the Magnet Cove Barium Corporation.

He skipped the same 2 valves again today

Both are still in adjustment. Still no leaks, not even at the shank! Both are OIC plug valves. If he's curious enough to dismantle one, he'll see the OIC gland and O-ring construction that saves him time and cussing. It's different from other plug valves he's seen.

Three efficient seals prevent shank leakage on OIC plug valves. Concentric grooves machined into the gland liner form a "labyrinth" seal. The liner also retains an O-ring in contact with the plug's top face for a second positive seal. And resilient packing between gland and gland liner forms the third seal.

But the maintenance man measures design by *results*. OIC plug valves get his O. K. because they stay in adjustment a long time without leakage. However, if *you* are interested in the exclusive gland design and construction of these OIC plug valves, write for specification literature.

The Ohio Injector Company • Wadsworth, Ohio

OIC VALVES

FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

TRADE PERSONALS

Paul Courtney has been appointed general manager of Cardwell Manufacturing Company. The new general manager of Cardwell Manufacturing Company has

Paul Courtney

J. T. Tucker

recently resigned as president and director of the George E. Failing Company.

J. T. (Tommy) Tucker was named general manager of sales for Cardwell. Until recently, Tucker was vice president in charge of sales at the Failing Company.

Lester W. Hall has been elected vice president and a director of the Eastman Oil Well Survey Company. Previously Hall was a financial advisor for Eastman.

Robert M. Greer, first vice president, will serve as chief executive officer of the George E. Failing Company, as provided by the company's by-laws. This action follows the resignation of **Paul Courtney** as Failing president. Greer has been associated with the Failing Company for 22 years. The Failing Company is a subsidiary of Westinghouse Air Brake Company.

R. M. Greer

L. W. Hall

J. L. Vint, Jr.

J. W. Tullis

J. L. Vint Jr. has been elected president of Unit Rig & Equipment Company. He succeeds **Kenneth Davis Jr.,** who will join Loffland Brothers Drilling Company. **J. W. Tullis** has been named executive vice president of Unit Rig.

Vint held the position of vice president — sales prior to his recent promotion, while Tullis was general works manager.

W. E. McCoy

F. B. Doonan

William E. McCoy has been appointed sales manager of Caterpillar's Southwest division, with headquarters in San Francisco, California. He was eastern sales division sales manager until recently.

Frank B. Doonan has been appointed industrial sales engineer in charge of the new sales and service office for Electro-Motive Division of General Motors Corporation at Morgan City, Louisiana. The new office opened July 1 in the Offshore Oil Center at Morgan City.

ENGINEERS and CONSTRUCTORS

OIL • GAS • WATER
PRODUCTS PIPELINES
PUMPING STATIONS

WILLIAMS BROTHERS

WILLIAMS BROTHERS NATIONAL BANK OF TULSA BLDG.
TULSA, OKLAHOMA • CABLE ADDRESS: WILLBROS.
New York • Washington • Louisville • Minneapolis • New Orleans
CANADA • BOLIVIA • COLOMBIA • ECUADOR • VENEZUELA • ENGLAND

The Petroleum Industry's Oldest Engineering Publication

That is The Petroleum Engineer, read and relied upon by operating men throughout the U. S. and sixty-seven foreign countries for twenty-five years... the same publication which has recently undergone changes in line with twenty-five years of industry progress.. the most practical and progressive re-modeling job conceivable, to fill the needs of operating men engaged in each division of the industry.

Scan carefully the copy in your hands, noting the calibre and "personal assistance" value of its contents. It brings you monthly coverage of operations, news, personals and pictorials nearest your interest, in addition to world petroleum developments and news... to *provide you a publication of 100% practical value.*

USE THE ENCLOSED CARD to Start Your Personal Copy Today

The Petroleum Engineer
P. O. Box 1589 **Dallas 1, Texas**

these top-rated rig suppliers help butter your bread!

Throughout the oil country, these leading rig manufacturers bring you the best possible service and equipment *to help you make your profits!* Meeting the demands of the expanding oil industry, they carefully select component units for their drilling rigs that will provide dependable operation, long service life and outstanding performance.

That's why we, at White Diesel, consider it a privilege to be associated with these companies. They sell White's new Super PTD Diesel or dual fuel engines available from 364 to 750 continuous B.H.P., and Superior gas engines from 320 to 630 continuous B.H.P., for rugged, heavy-duty drilling requirements. Their sales and service engineers are always at your service. Get in touch with them by telephone, telegram or letter for complete information on White's Superior Engines . . . or contact a White Diesel field representative available in all oil field areas, or write to:

WHITE DIESEL ENGINE DIVISION

THE WHITE MOTOR COMPANY *Plant and General Offices: Springfield, Ohio*

Superior ENGINES · ATLAS Imperial DIESEL ENGINES · White DIESEL

Bethlehem Supply Company
21 East Second Street
Tulsa 3, Oklahoma

The Brewster Company, Inc.
450 North Market Street
Shreveport, Louisiana

Continental Supply Company
Continental Building
Dallas 1, Texas

Dominion Oil Field Supply Co., Ltd.
Calgary, Alberta, Canada

Emsco Manufacturing Company
Continental Building
Dallas 1, Texas

Ideco Division
Dresser Industries, Inc.
P.O. Drawer #3350
Beaumont, Texas

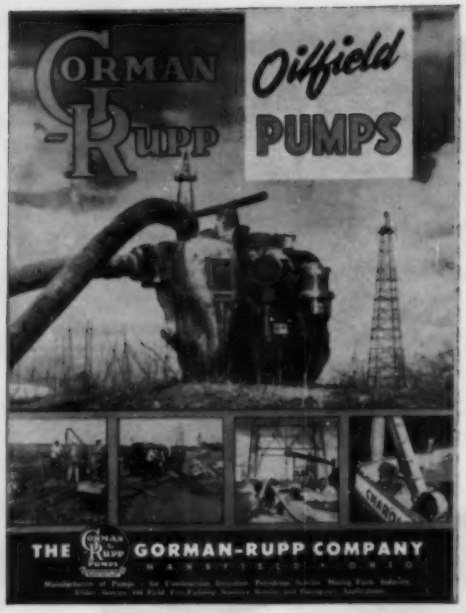
Mid-Continent Supply Company
Mid-Continent Building
Fort Worth, Texas

The National Supply Company
P.O. Box 416
Pittsburgh, Pennsylvania

Oil Well Supply Division
U.S. Steel Corporation
P.O. Box 478
Dallas 1, Texas

Unit Rig & Equipment Company
P.O. Box 1889
Tulsa 1, Oklahoma

Wilson Manufacturing Company
P.O. Box 329
Wichita Falls, Texas



Do you have this informative 20-page buyers' guide on pumps?

If you specify or purchase oilfield equipment, you will want to have on file this recently published catalog. Featuring all the many models of Gorman-Rupp Pumps useful to this important field, it contains specifications, performance data, cutaway views and application information. A copy will be sent you on receipt of the coupon below, by our Mid-Continent & Gulf Coast Oilfield Representative.

CONTENTS OF CATALOG

Self-Priming Centrifugal Pumps for
- DRAINAGE or WATER SUPPLY
- GENERAL UTILITY (Lightweight)
- PETROLEUM PRODUCTS
- JETTING, DRILLING, FIRE PROTECTION, MUD or SLURRY HANDLING
- HEAVY LIQUIDS or LIQUIDS WITH REDUCEABLE SOLIDS (Trash Type)
- HIGH AND DRY SUMP PUMPING

Diaphragm Pumps
Standard Centrifugal Pumps
O. S. C. Units (Tank and Pump Complete for Mounting on Customer's Truck)

THE GORMAN-RUPP COMPANY
305 Bowman Street • Mansfield, Ohio

FREE!

HENRY H. PARIS DISTRIBUTOR, INC.
1125 Rothwell St., Houston, Texas
Please send me the Gorman-Rupp Oilfield Pump Catalog.

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

Gorman-Rupp PUMPS

▸ **John G. Seiler,** formerly general sales manager, has been elected president of Tube Turns, a division of National Cylinder Gas Company. He succeeds **George O. Boomer,** who has announced his retirement. Boomer will continue as chairman of the executive committee of the parent concern. Seiler was elected a vice president of National Cylinder Gas at the same time he was elevated to the presidency of Tube Turns.

J. G. Seiler

▸ **William W. (Bill) Cabell** has been appointed vice president and general sales manager for the C. A. Mathey Machine Works, Inc., and **L. V. Orton** is being promoted to vice president in charge of development and production.

W. W. Cabell

L. V. Orton

Cabell, former treasurer, is replacing **George L. Temple,** who is now general manager of Reading and Bates Off Shore Drilling Company. Orton was formerly plant superintendent.

▸ Numerous personnel changes have been announced by Schlumberger Well Surveying Corporation.

W. W. Goode has been named assistant manager of the Southeast area in New Orleans, Louisiana. Formerly, he was Permian Basin division manager at Midland, Texas. **F. L. Bryan** has replaced Goode in Midland. Bryan had been manager of the Pacific Valley division at Bakersfield, California.

W. W. Goode

F. L. Bryan

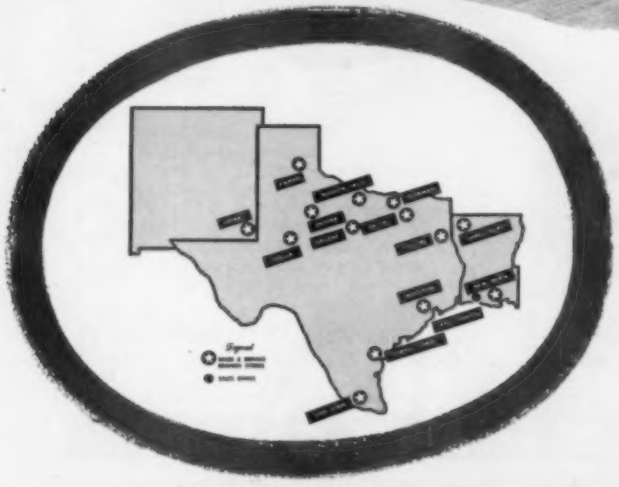
The new Taft district manager in California is **William Plasch.** Plasch has served Schlumberger in several other California locations. **J. W. Chance** is now manager of the Jennings, Louisiana, location. Chance formerly was a division sales representative.

New manager of the Electra, Texas, location is **J. K. Ryan,** a former company field engineer in several locations. Taking over as manager in Big Lake, Texas, is **Roy R. Shourd Jr.** Shourd has served Schlumberger as a field engineer in several Texas locations.

TWO THINGS that guarantee you genuine Waukesha Parts

. . . the Waukesha Sales & Service, Inc., emblem on the uniform of the man from whom you buy your parts and on the truck that delivers them.

Your Waukesha engine will give its best performance only when fitted with genuine Waukesha parts. So always look for the Waukesha Sales & Service, Inc., emblem when you purchase replacement parts. Waukesha Sales & Service, Inc., branches and sales points, located throughout the oil country, carry complete stocks of engine parts, made to fit your engine and made to last, giving you the best possible performance from your Waukesha engine. So, remember the Waukesha Sales & Service, Inc., emblem the next time your engine needs a new part.



WAUKESHA

Sales & Service, Inc.

1422 MAURY ST. • HOUSTON, TEXAS

EXCLUSIVE DISTRIBUTORS FOR WAUKESHA PRODUCTS IN TEXAS, NORTH AND WESTERN LOUISIANA, SOUTHERN ARKANSAS AND NEW MEXICO

WORLD'S LARGEST DISTRIBUTOR OF OIL FIELD ENGINES

PULSATION

. . . HANDLED WITH EASE BY

DeZURIK VALVES

On suction lines handling rotary drilling mud, DeZurik Easy Operating Plug Valves remain in hard service month after month . . . *despite* pulsation and vibration!

The dead-tight seal of the rubber-faced plug and metal valve seat is not affected by line surge or valve strain. The plug won't distort or stretch.

Exclusive eccentric action permits drip-free shut-off or full-open flow with an e-a-s-y quarter-turn of the handle!

DeZurik Valves are manufactured in sizes from ½" thru 20"; in all metals; in lever, gear, pneumatic, hydraulic and electric operated models.

WRITE FOR DETAILS
Representatives in all principal cities.

DeZURIK
SHOWER COMPANY
SARTELL, MINNESOTA

▸ **John Wilson** has been elected vice president in charge of sales for Midwestern Pipe Line Products Company. He was in

M. E. Maddox

John Wilson

Tulsa, Oklahoma, as sales manager for the past two years.

M. E. Maddox has been appointed district sales representative for the firm's Mid-Continent area, with headquarters in Tulsa.

▸ Jones & Laughlin Supply Division has announced two managerial appointments

W. R. Clarke

Jack Judd

in newly created production and drilling equipment divisions of the firm's sales operations.

William R. Clarke, formerly chief engineer, has been appointed manager-production equipment sales, and **Jack Judd,** formerly rotary machinery salesman, has been advanced to manager-drilling equipment sales.

▸ **Dr. J. M. Lebeaux** has been named research and development engineer for the Oil Center Tool Company. He was formerly employed by Stanolind Oil & Gas Company and is a former assistant professor of petroleum engineering at the University of Texas.

J. M. Lebeaux

J. R. Yancy

J. R. (Dick) Yancy has joined O-C-T and will be assigned to product development work. Until recently, Yancy was with the A-1 Bit & Tool Company, having been vice president in charge of engineering and manufacturing and a member of the board of directors.

▸ **William Couch** is now a sales representative, attached to the Englewood, New Jersey, office, for Bucyrus-Erie Company.

AUTO-LITE

. . . for TEMPERATURE RECORDING . . .

One of the many uses for Auto-Lite Recorders is the application shown below . . . a natural gas field meter run.

Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

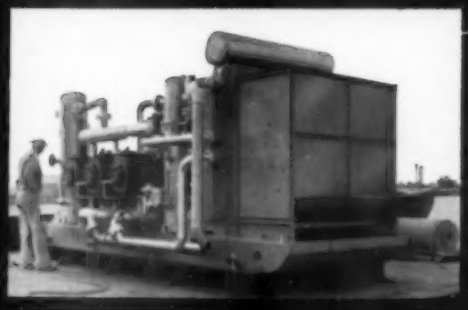
THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS & INDICATORS

BEAIRD-INGERSOLL-RAND

Packaged Compressor Plant

Lowest Cost Per Horsepower Installed



GULF REFINING COMPANY BAYOU COUBA FIELD COMPRESSOR STATION—equipped with a Beaird-Ingersoll-Rand 165 h.p. 6 JVG four cycle gas engine driven compressor, Young radiator with lubricating oil cooler and gas coolers, and all necessary controls for unattended operation. Other sizes 110 to 660 h.p.

Packaged Compressor for —

BARGE MOUNTED GAS LIFT SERVICE

Gulf Refining Company has installed this barge mounted compressor station in Bayou Couba Field, Louisiana. Part of a 21-well gas lift operation, the 165 h.p. 6 JVG Beaird-Ingersoll-Rand packaged unit was added to supplement three high gas-oil ratio wells formerly used to produce the field. Picking up from the lifted wells at 50 psig., the compressor boosts the gas into the injection system at 825 psig. where it is joined with make-up gas drawn from the high ratio wells. By using a closed gas lift system Gulf has stopped flare gas losses and extended the life of the high gas-oil ratio wells.

Completely packaged and on its own skid base, the unit was installed on a conventional cargo barge. Piping and plant layout has been designed to facilitate the economical addition of a second compressor to the station when required.

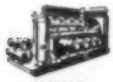
Fully automatic in operation, the compressor is equipped with speed and pressure regulators which permit it to swing with changes in line pressure by varying the engine speed through a range of 50% to 100%. Other controls watch over the unit day and night ready to shut it down should any unusual operating condition occur. Only routine scheduled inspection and maintenance is required for 24-hour unattended operation.

Let us tell you about the economy of using Beaird-Ingersoll-Rand packaged compressor plants for offshore and tidelands production.

MACHINING
MANUFACTURING
STEEL WAREHOUSE

BEAIRD

THE J. B. BEAIRD COMPANY, INC.



PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

LP-GAS SYSTEMS

SHREVEPORT, LOUISIANA • Sales Offices: *Dallas, Houston, Corpus Christi and Midland, Texas • New Orleans, Louisiana • Tulsa, Oklahoma • Denver, Colorado • Los Angeles, California, and Cie. Ingersoll-Rand, Paris, France*

...SKILLS AT YOUR COMMAND

King Sized storage vessels for a refinery in Mexico — packaged compressors for a Texas gas field — LP-Gas systems for farm homes in Minnesota — legs of steel for offshore drilling rigs — axles for strip-mining mammoths in Montana.

In these Beaird-built products are combined the creative talent and manufacturing dependability that have created a highly diversified source of production. With five manufacturing divisions, Beaird offers its customers the benefits of the integrated facilities and experience of the entire production team.

This reserve of tools and skills at Beaird is at your command.

Why not check with Beaird on your next equipment requirement or for outside machining and fabricating service.

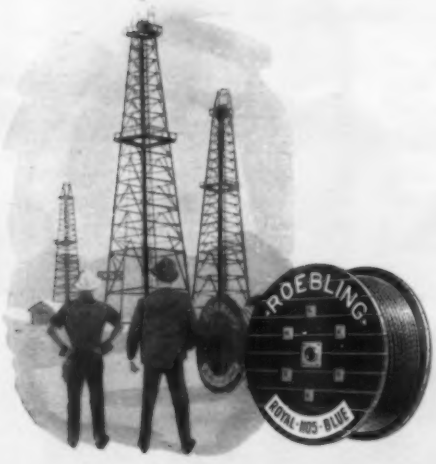
BEAIRD

COMPRESSOR DIVISION, INCLUDING PLANT STORAGE • L P-GAS AND ANHYDROUS AMMONIA EQUIPMENT DIVISION • SPECIAL PRODUCTS DIVISION • MACHINE PRODUCTS DIVISION • STEEL WAREHOUSE

THE J. B. BEAIRD COMPANY, INC.
SHREVEPORT, LOUISIANA
STOCKTON, CALIFORNIA
CLINTON, IOWA

faster

Royal Blue
has won acceptance *faster* than any other wire rope in Roebling history



John A. Roebling's Sons Corporation, Trenton 2, N. J., Subsidiary of The Colorado Fuel and Iron Corporation BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 51 SLEEPER ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 2340 GLENDALE-MILFORD RD., EVENDALE • CLEVELAND, 19325 LAKEWOOD HEIGHTS BLVD. • DENVER, 4901 JACKSON ST. • DETROIT, 915 FISHER BLDG. • HOUSTON, 6216 NAVIGATION BLVD. • LOS ANGELES, 5340 E. HARBOR ST. • NEW YORK 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • PITTSBURGH, 1723 HENRY W. OLIVER BLDG. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST AVE. S. • TULSA, 321 N. CHEYENNE ST. • EXPORT SALES OFFICE, 19 RECTOR ST., NEW YORK 6.

Increase efficiency . . . reduce maintenance

on your heat transfer equipment . . .

Call an EFCO engineer today

Capable EFCO mechanical engineers have the diversified experience, from hundreds of jobs designed to API-ASME or ASME Codes and TEMA specifications, to anticipate your individual heat transfer problems . . . and to design job-rated heat transfer systems that will provide *guaranteed performance* at peak operating efficiency, long life with low, trouble-free maintenance.

Job-rated EFCO installations are efficiently handling pressures to 5000 psi. Equipment for your special requirements . . . minimum low to maximum high temperature services . . . can be successfully provided.

Call an experienced EFCO engineer today and get guaranteed performance from your heat transfer equipment.

EFCO

HEAT TRANSFER EQUIPMENT

ENGINEERS & FABRICATORS, Inc.

P. O. BOX 7395
HOUSTON 8, TEXAS

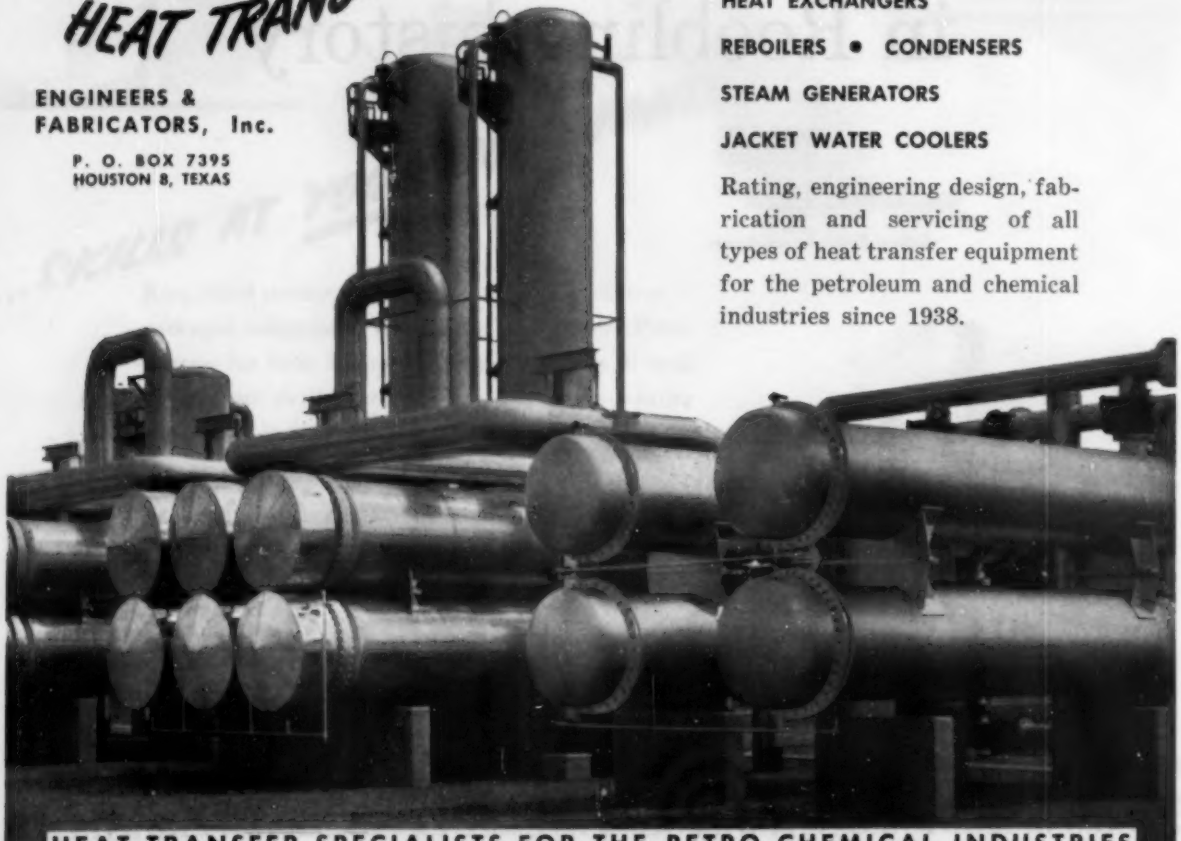
HEAT EXCHANGERS

REBOILERS • CONDENSERS

STEAM GENERATORS

JACKET WATER COOLERS

Rating, engineering design, fabrication and servicing of all types of heat transfer equipment for the petroleum and chemical industries since 1938.

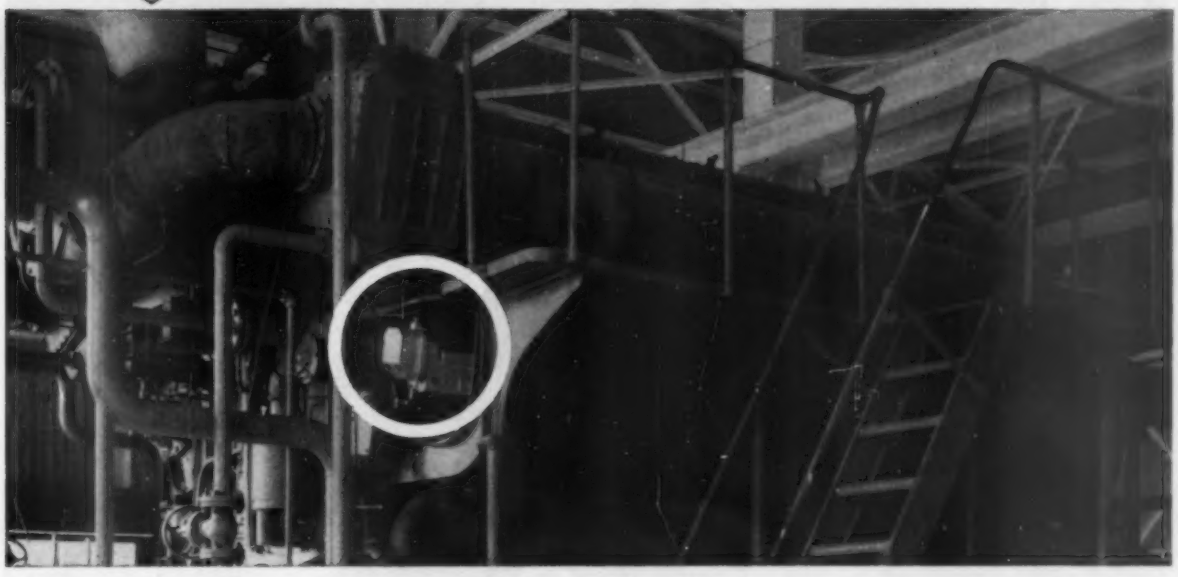


HEAT TRANSFER SPECIALISTS FOR THE PETRO-CHEMICAL INDUSTRIES

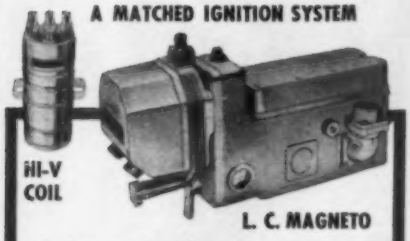
6119

BLUE SUNOCO

SUN OIL COMPANY



uses Cooper-Bessemer Engines with BENDIX MAGNETOS at their Marcus Hook Refinery!



1. Long service life
2. Simplified maintenance
3. Longer spark plug life
4. No unscheduled ignition shutdowns
5. Positive spark timing
6. High voltage output
7. Matched ignition system
8. Single or dual ignition
9. Flame proof
10. Low maintenance costs
11. For engines of 6 through 16 cylinders

Pictured above is a section of the power equipment used by the Sun Oil Company in an ammonia plant at their huge Marcus Hook Refinery.

Typical of Sun's utilization of the most modern equipment in their refining process is this Cooper-Bessemer Model LSV12 engine equipped with Bendix* L. C. Magneto and Hi-V Coil.

Because the Bendix L. C. is a completely new type of magneto, it incorporates the latest developments in engineering, design and production techniques. The result is a matched ignition system—L. C. Magneto plus Bendix Hi-V transformer coils—that delivers more than ample voltage with greatly reduced maintenance costs.

That's why whenever top performance is a must, you'll find more and more important operators making the new Bendix L. C. Magneto their choice.

*TRADE MARK

SCINTILLA DIVISION OF BENDIX AVIATION CORPORATION, SIDNEY, NEW YORK

Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

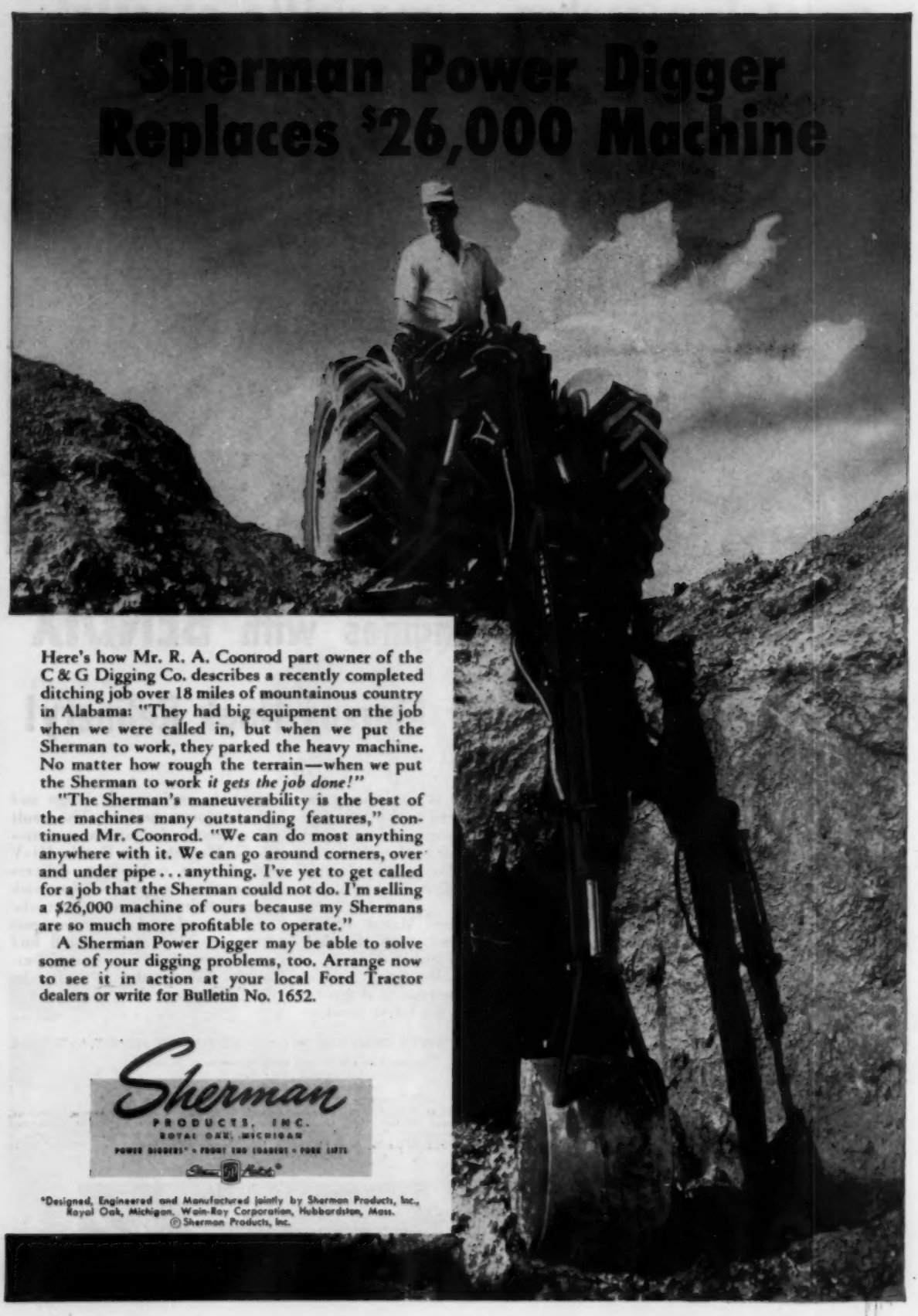
Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., St. Laurent, Montreal 9, Quebec.

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • 512 West Avenue, Jenkintown, Pennsylvania • Paterson Building, 18038 Mack Avenue, Detroit 24, Michigan • 5906 North Port Washington Road, Milwaukee 17, Wisconsin • Human Building, 120 West Second Street, Dayton 2, Ohio • 8401 Cedar Springs Road, Dallas 19, Texas • Boeing Field, Seattle 8, Washington • 1701 "K" Street, N. W., Washington 6, D. C.

Bendix
SCINTILLA DIVISION

Bendix
AVIATION CORPORATION

Sherman Power Digger Replaces $26,000 Machine



Here's how Mr. R. A. Coonrod part owner of the C & G Digging Co. describes a recently completed ditching job over 18 miles of mountainous country in Alabama: "They had big equipment on the job when we were called in, but when we put the Sherman to work, they parked the heavy machine. No matter how rough the terrain—when we put the Sherman to work *it gets the job done!*"

"The Sherman's maneuverability is the best of the machines many outstanding features," continued Mr. Coonrod. "We can do most anything anywhere with it. We can go around corners, over and under pipe . . . anything. I've yet to get called for a job that the Sherman could not do. I'm selling a $26,000 machine of ours because my Shermans are so much more profitable to operate."

A Sherman Power Digger may be able to solve some of your digging problems, too. Arrange now to see it in action at your local Ford Tractor dealers or write for Bulletin No. 1652.

Sherman
PRODUCTS, INC.
ROYAL OAK, MICHIGAN
POWER DIGGERS* • FRONT END LOADERS • FORK LIFTS

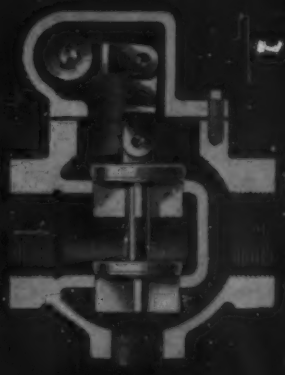
*Designed, Engineered and Manufactured jointly by Sherman Products, Inc., Royal Oak, Michigan, Wain-Roy Corporation, Hubbardston, Mass.
© Sherman Products, Inc.

FISHER®

OIL PRODUCTION VALVES

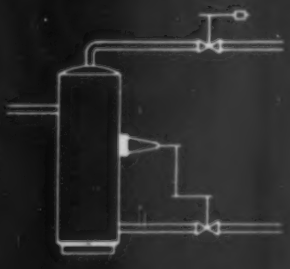
HERE'S JUST A FEW OF THE VALVES FISHER CAN PROVIDE FOR YOUR OIL PRODUCTION WORK—

GAS VALVE



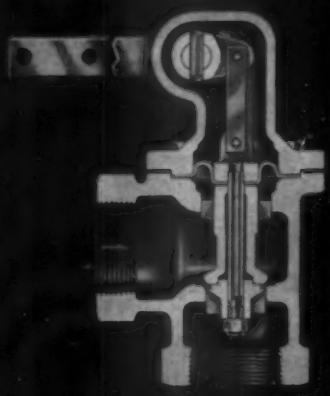
TYPE 9G—an economical and simple separator back pressure valve.

SIZES—Screwed 2", 3" and 4".
Flanged—3" and 4".



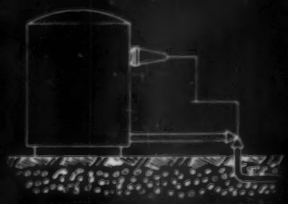
Low Pressure Separator Back Pressure Valve

OIL VALVE

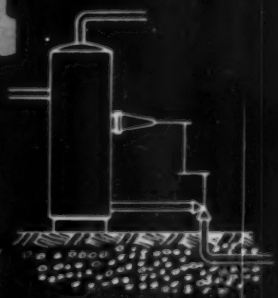


TYPE 1907—for low pressure oil and gas separator. Also very successfully used as a water dump valve.

SIZES—Screwed 2" and 3".
Flanged—2", 3" and 4".

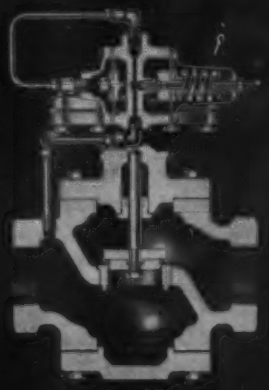


Water Dump Valve On Tank



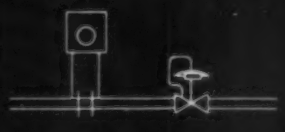
Separator Low Pressure Oil Valve

BACK PRESSURE VALVE

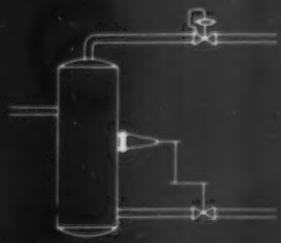


TYPE 63—here's a pilot operated valve that will give close regulation and tight shut-off.

SIZES—Screwed 2".
Flanged—3" and 4".

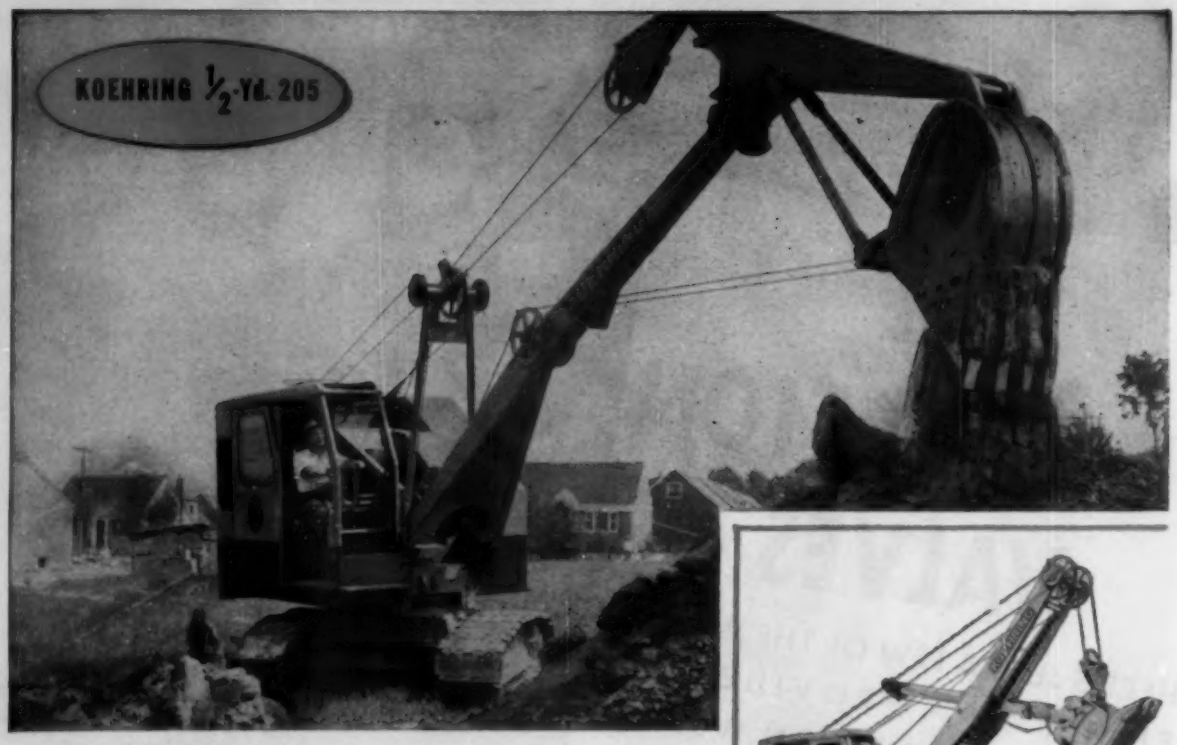


Field Back Pressure Valve



Separator Low Pressute Back Pressure Valve

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA · WOODSTOCK, ONTARIO
LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL



digs 17¾ feet deep . . . dumps at 8¾ foot height

With its long, deep reach, Koehring ½-yard 205 hoe digs 17¾ feet below grade . . . has 8' 9" clearance height at beginning of dump to load trucks. Maximum cutting width, with side cutters, is 31 inches. During the hoist-and-swing cycle, close-coupled dipper pulls up tight to boom, avoids spillage. Powerful cable crowd, fast line and swing speeds maintain big-yardage production. Heavy-duty, box-section boom and dipper arm resist side-sway in toughest digging. Operators like the 205's ease of operation . . . *you'll* like its EXTRA WORK CAPACITY. Here are some of the heavy-duty advantages you get that increase production with every 205 attachment:

Big 20-inch main drum clutches.

Only 2 major shafts in upper machinery . . . simple, accessible.

Heavy-duty splined shafts . . . carburized, hardened gears.

4 hook-rollers, eccentric adjustment.

Automatic crawler traction-brakes.

Standard or extra-long crawlers . . . with 16, 20, or 24-inch shoes.

Independent traction . . . optional.

Antifriction power-flow for dig, hoist, swing, travel.

Crawler-mounted 205 brings you: ½-yard dipper capacity as a shovel or hoe . . . ½ to ¾-yard bucket capacity as a clamshell or dragline . . . 10-ton lift crane.

Truck-mounted 205 has 15 tons lift capacity, 25 to 55-ft. boom, plus max. 30-ft. jib. Travels 32½ m.p.h. Converts to all standard excavator, crane attachments.

Get the complete story on this new 205. Ask your Koehring distributor for details, or write for bulletin.

To: KOEHRING CO., Milwaukee 16, Wis.
Send us bulletin on the new ½-yard, 15-ton 205.

NAME _____ TITLE _____

DIVISION _____

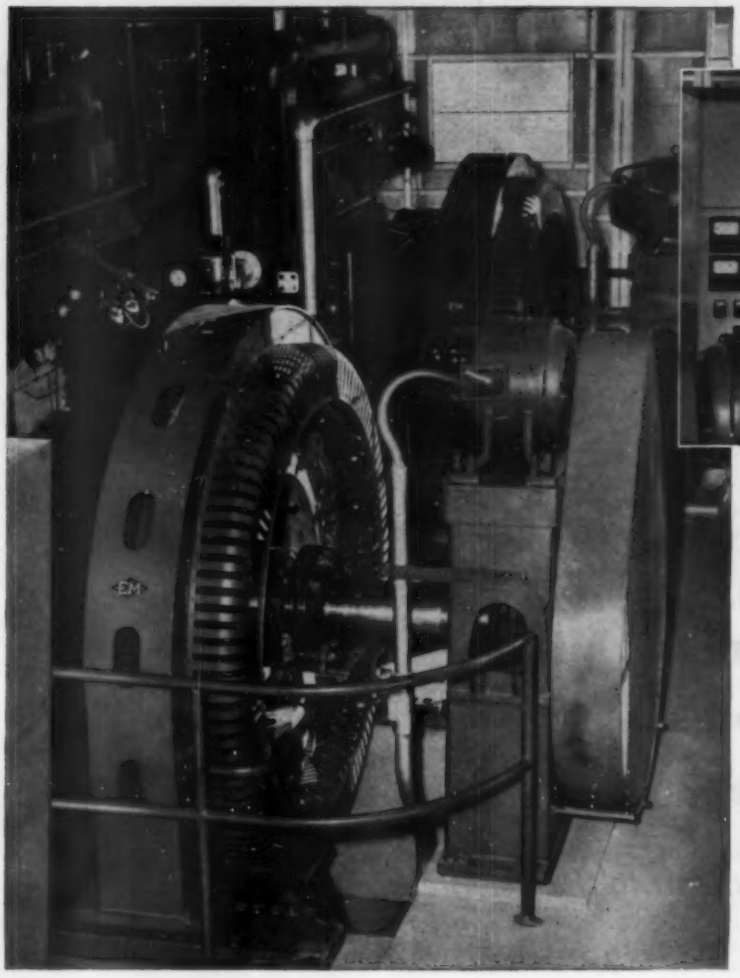
STREET _____

CITY _____ STATE _____

KOEHRING

COMPANY • Milwaukee 16, Wis.

Subsidiaries: PARSONS • KWIK-MIX • JOHNSON



What Makes Station Operation at Worland so Dependable?

● Reliability is a big word in the Montana-Dakota Utilities Co. gas compressor station at Worland, Wyoming, designed, engineered and built by Stearns-Rogers Mfg. Company of Denver. You find it "built-in" in every phase of this pipe line station's activities . . . from the main compressing operation to station lighting and auxiliaries such as cooling fans, water circulating pumps, water well pumps and other units.

Worland station's electric power generators have received the same intensive design and engineering as the major compressors. Engines have been selected carefully, and E-M Engine-Type Synchronous Generators were specified as the most dependable source of station power, 24 hours a day. These generators, rated at 463 kva, 370 kw, 0.8 power factor, 327 rpm, 480 volt, 3 phase, 60 cycle, provide all station power for plant motors and lighting. E-M Switchgear at Worland includes two generator panels and a distribution panel.

You'll find E-M Generators and pre-engineered Switchgear unusually well-suited for pipe line service. A special E-M insulation treatment protects generator coils against corrosive vapors. Big motors can be started with minimum voltage dip. Parallel operation is smooth and flickerless. And E-M design simplicity plus careful attention to full strength in the smallest details assures years of dependable operation at low cost.

Keep in mind E-M's specialized experience on pipe line power generation equipment of various types. Ask your nearest E-M sales engineer for information, and write the factory for E-M Synchronizer No. 35.

ELECTRIC MACHINERY MFG. CO.
MINNEAPOLIS 13, MINNESOTA

2200-TPA-2138

E-M

Specialists in Generator and Switchgear Engineering

an important announcement to the petroleum industry...

with the expansion of its line of quality fatty nitrogen products, the

CHEMICAL DIVISION OF General Mills

is pleased to announce the appointment of

Dearborn CHEMICAL COMPANY
CHICAGO 54, ILLINOIS

as sales agent to the petroleum industry

- -

Dearborn Chemical Company will handle these products of the Chemical Division of General Mills...

Aliquats*: These fatty quaternaries combine excellent corrosion inhibiting qualities with bactericidal activity. They are used in secondary oil recovery, circulating water systems and cutting oil formulations.

Alamacs*: These are water soluble or dispersible compounds made from primary amines. They are important as corrosion inhibitors.

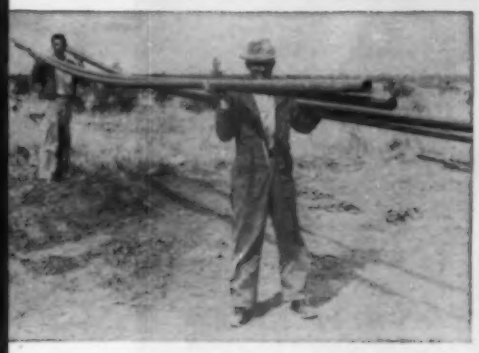
Alamines*: This is a versatile group of primary and secondary fatty amines, excellent for preventing the formation of scale and deposits, and for inhibiting corrosion. Alamines may be dispersed in water with cationic and nonionic emulsifiers and are soluble in many organic solvents.

Diams*: These fatty trimethylene diamines are strongly alkaline and have high cationic activity. They are valuable in formulating corrosion inhibitors for crude oil production, transportation and storage. Their properties suggest many other interesting applications.

*Trade marks of General Mills

For more information on these four product lines, write Dearborn Chemical Company, Merchandise Mart Plaza, Chicago 54, Illinois for booklet, "Fatty Nitrogen Primer." A competent technical service staff is ready to work with you on specific problems.

CHEMICAL DIVISION OF General Mills
KANKAKEE, ILLINOIS



Thirty-foot lengths of 2-inch, Schedule 40 National PVC Plastic Pipe. Each of these easy-to-handle lengths actually weighs less than 20 pounds.

2,800 feet of
USS NATIONAL* PVC PLASTIC PIPE
laid in 1¾ hours

The TXL Oil Corporation is putting National Polyvinyl Chloride Plastic Pipe to its first rough oil field test—as a gathering line subject to paraffin deposits. A pipe laying crew made the installation in the Permian Basin, 12 miles south of Odessa, Texas, laying the 2,800-foot line in less than an hour and 45 minutes.

Normal impact, two-inch, plain-end pipe was used. Fittings were attached by solvent cementing. The 90 lengths of pipe were coupled at the rate of almost a joint a minute.

* * *

National Polyvinyl Chloride Plastic Pipe is available in two types, in sizes ½" to 6" inclusive and in Schedules 40 and 80.

NORMAL-IMPACT —for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

HIGH-IMPACT —for installations requiring excellent chemical resistance and a high degree of toughness even at low temperatures.

Polyvinyl Chloride Pipe possesses high chemical resistance to acids, alkalis, salt solutions, alcohols and many other chemicals. It is rigid and light weight . . . can be joined by threading (Schedule 80 only), by solvent cementing, heat welding or with adhesives. National Polyvinyl Chloride Plastic Pipe is marked every 2 feet with size, schedule, pressure and temperature.

Nontoxic, the pipe resists deterioration from sunlight, fungi, bacterial action and soils. Its smooth internal surface offers low flow resistance.

For further information on USS National Polyvinyl Chloride Plastic Pipe, send for Bulletin No. 24. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

*Trademark

Fitting being solvent-cemented in place.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS NATIONAL *plastic* PIPE

UNITED STATES STEEL

Gulf Sales Engineer Thomas H. Chambers, Beaumont, Texas District (left) and R. W. Haney, Chief Engineer of the United Gas Pipe Line Company's Goodrich, Texas Compressor Station, inspect the company's six Ingersoll Rand 1320 H.P. K.V.G. engines. All these engines are lubricated with Gulf Security.

Lock out high maintenance costs in your gas transmission plants

with GULF SECURITY

Gulf Security's outstanding record in the lubrication of pipeline gas engine compressor units is your assurance of smooth, continuous operation. In scores of gas transmission plants this high quality straight mineral oil helps prevent operating troubles and contributes to low maintenance costs.

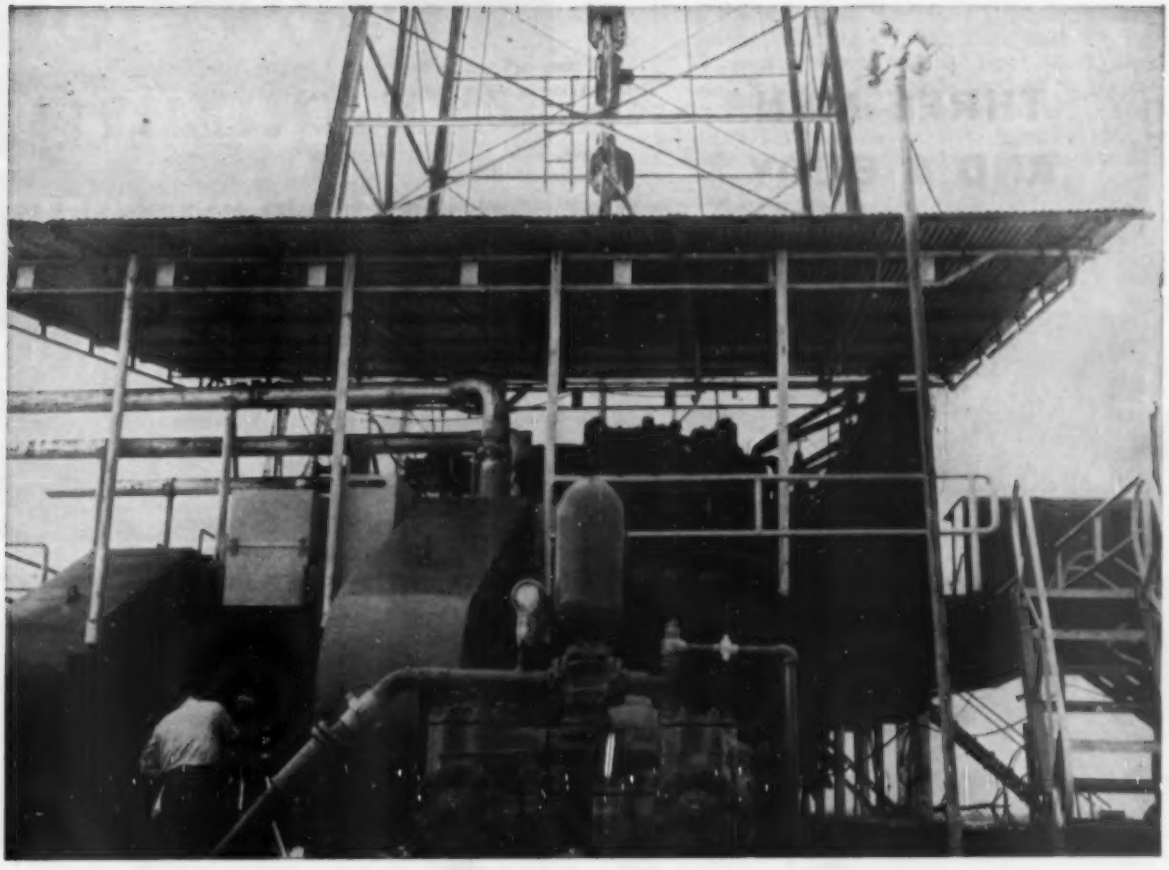
Gulf Security is a non-additive oil that does not cloud liquid filled lubricators of power cylinders, compressor cylinders, and packing glands. After years of operation with Gulf Security, cylinders and piston rings of both compressors and power assemblies show negligible wear, and its excellent oxidation stability helps prevent the formation of acid and resins in the crankcase system.

Make certain your units receive safe, effective lubrication protection—specify Gulf Security. And remember that Gulf provides the services of a trained, experienced petroleum expert—the Gulf Sales Engineer—to help you with any problem involving a petroleum product. Consult the telephone directory for the number of your nearest Gulf office.

GULF

Gulf Oil Corporation • Gulf Refining Company
1822 Gulf Building, Pittsburgh 30, Pa.

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS



Deephole Drilling . . . In a Hurry !

. . . the acceleration, lugging power, and dependability you get from Le Roi L3460 and L4000 engines mean faster round trips and lower drilling costs.

WHEN you have to go deep you need plenty of horsepower. And the place to get it is from Le Roi's L3460 with 600 max. hp. or its big brother, the L4000 with 655 max. hp.

You get much more, too. You get compactness. These V-12 overhead-valve engines are only 164 in. long. That makes them ideal for drill-rig installation, because they pack a lot of power in a small space — give you more horsepower per dollar.

But that's not all you get from these high-output engines. They represent the first, truly new design concept in 15 years. They have improved fuel economy; integral crankcase and cylinder construction for greater rigidity; longer bearing life; hydraulic valve lifters; better manifolding; husky crankshaft with integrally forged counterweights for unbelievably smooth operation — modern features that mean lightning response to load demands, outstanding performance and dependability.

Like all Le Roi engines, they're built to stand oilfield handling; they're easy to service; they have a wide speed range up to 1350 rpm; and they operate on natural gas, butane, or gasoline.

Ask your supply house or Le Roi distributor to show you an L3460 or L4000 at work. See for yourself why they can help you make hole faster. Literature is also available — just write us for it.

P-139

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 1, Wisconsin

PORTABLE AIR COMPRESSORS · TRACTAIR · STATIONARY AIR COMPRESSORS · AIR TOOLS · ENGINES

THREE MEN AND A BUOY

in Search of Oil

The men are Cities Service geologists, the buoy a marker used in undersea oil exploration.

That this search involves great expense, everyone agrees. That it will prove successful, no one can guarantee—since the odds for exploratory drilling are nine to one against a discovery. The Cities Service oil seekers, however, continue to chalk up impressive records in both land and sea exploration. Records such as 1955's one-out-of-three success ratio for test wells . . . far above the ratio for the oil industry.

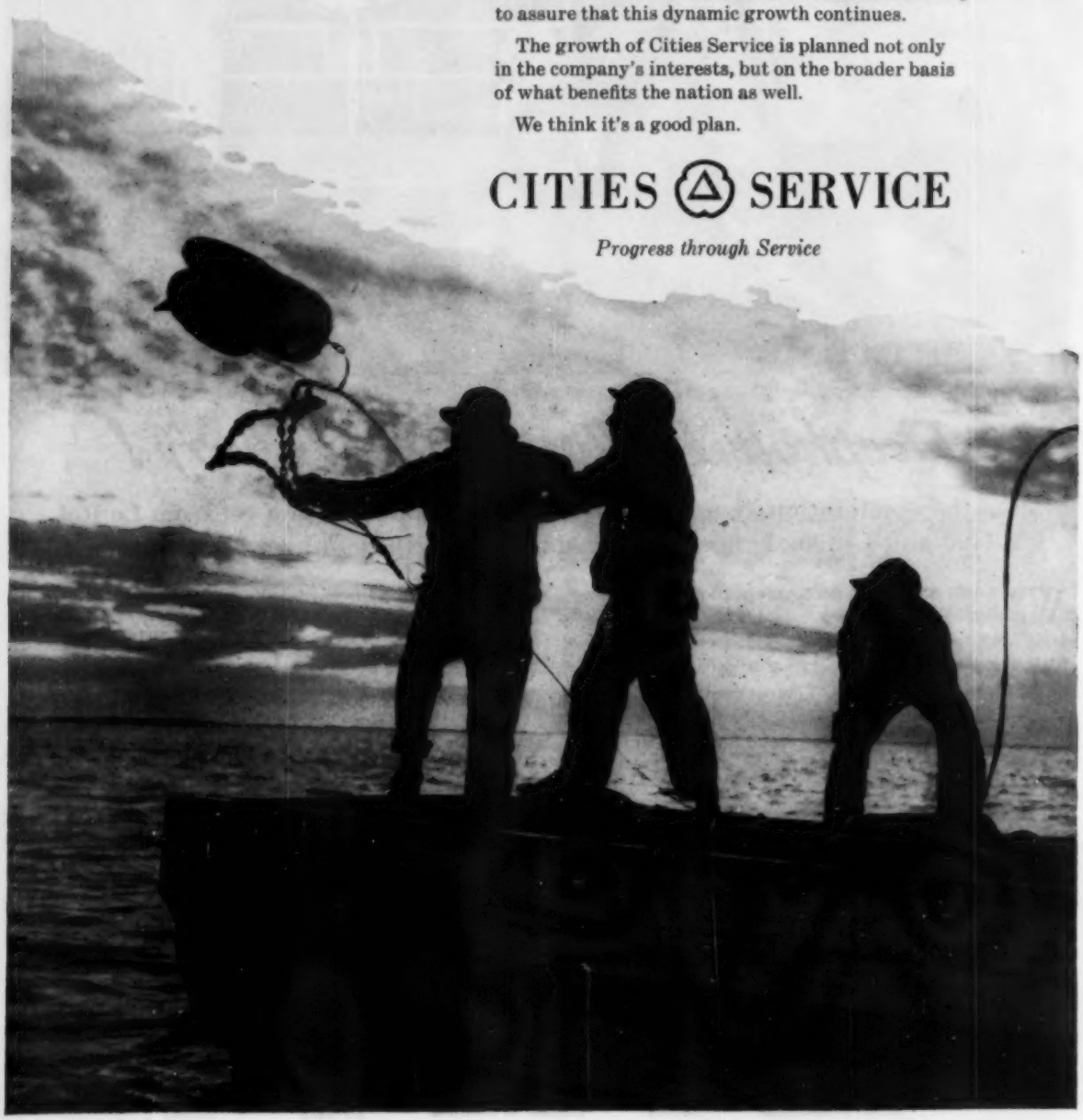
Here are other 1955 records: A new peak in production and sales of petroleum products, with sales up 17% . . . a 6% increase in natural gas sales . . . an all-time high in stockholders' equity . . . construction of an ultramodern Cities Service research laboratory to assure that this dynamic growth continues.

The growth of Cities Service is planned not only in the company's interests, but on the broader basis of what benefits the nation as well.

We think it's a good plan.

CITIES SERVICE

Progress through Service



Here's Why COLUMBIAN BOLTED STEEL TANKS "Just Fit Up Better"

For more than 60 years Columbian steel tanks have been the standard for tank tightness and lasting quality. Why do Columbians "just fit up better"? There are many reasons. First of all, the high-precision machinery Columbian uses in forming and punching the tank plates and decks . . . and the master-craftsmen in steel who operate those modern machines. But beyond that, it's the attention given to assuring the tight seal of every joint and seam when a Columbian tank is fabricated. The pictures here show how easy it is for a crew to fit up a tight tank — when it's a Columbian.

"Rubbering" the bottom: Synthetic gasket material is applied to center plate of Columbian tank bottom. Note short channel lengths for holding bolt heads.

Joining bottom segments: "Rubbered" on one edge and bolted to adjoining segments. Special wedge-shaped gaskets are provided for three-thickness (2 segments and center plate) joints.

Tight-Sealed bolt holes: Steel backed Neoprene washers are provided for all side and bottom seams. As bolts are tightened cup-shaped steel washers press rubber washers tight in and around bolt holes, forming a perfect, leak-proof seal.

Leak-proof Side-Bottom seam: The special wedge-shaped gasket is used for joints of 3 thicknesses (bottom and lap of 2 staves). To prevent any possible leak at flange radius, a special radius gasket—a Columbian extra—is inserted under stave's strip gasket.

Special Large-tank protection: For the double or triple bolt rows on large-capacity tanks, Columbian provides not only strip gaskets for each row but the special radius gaskets to span each row of holes.

No leak out at cleanout: Cover (either flat or extended) for cleanout is sealed tightly to stave. Strip gaskets extend beyond corner bolts with tank cement under laps of side and top gasket strips. Special radius gaskets are used under side strip gaskets at bottom flange.

Want to Know ALL About Columbian Tanks?

COLUMBIAN'S new BOLTED TANK CATALOG is more than just a catalog — it gives you the full story of tank construction in pictures . . . shows you the many ways Columbian bolted Steel Tanks are being used for crude and refined storage . . . in the oil fields . . . by communities and industries all over the world.

Write For Your FREE Copy Today!

COLUMBIAN STEEL TANK COMPANY

P. O. Box 4048K Kansas City, Mo.

For Tight Tanks Quick, write, wire or phone a Columbian Distributor.

TANKS FOR THE WORLD

T. M. Reg

Quick as a cat... Quiet as a mouse

CHAPMAN
Tilting Disc Check Valve

There, in a nutshell, is the story of a Chapman Tilting Disc Check Valve . . . quick as a cat, quiet as a mouse. It's designed that way. It's built that way . . . for fast, sure, quiet action. Or, in other words, it's yours for best performance at lowest long-range operating costs.

With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

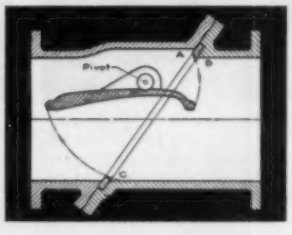
To put it briefly, with a Chapman Tilting Disc Check Valve, there's little or no maintenance even under severe operating conditions.

For Chapman Tilting Disc Check Valves in iron and steel . . . valves for handling fluids or gases under a wide range of pressures . . . valves for replacement or new piping systems . . . just check our Catalog 30-A. It's yours for the asking. Send for it now.

The CHAPMAN Valve Mfg. Company
INDIAN ORCHARD, MASSACHUSETTS

Never a Flutter, Never a Slam!

Designed and Built for Quiet Efficient Operation



In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.

You belong here, too! You may be anything from refinery chemist to driller. But as an oilman, you help the farmer feed himself and 18 others—triple his great-grandfather's food production. Oil provides the energy for horsepower to replace manpower. Oil helps keep farm crops and stock thriving, farm families comfortable. If you hear unfair criticism of oilmen, remember how we serve the farmer. In fact, oil has an outstanding record of serving *everybody*. It's our job to say so...loud and strong! **SHELL OIL COMPANY**

Pumping Progress Report

FOR PETROLEUM ENGINEERS

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

PUMPING LIQUID BUTANE AND PROPANE is a typical operational headache successfully handled by the Aldrich Pump Company Engineers. It was a particularly tough pumping problem for one large pipe line company; they had to move butane 186 miles — from a Texas oil field to a Gulf Coast refinery.

PUMPING LIGHT-GRAVITY FLUID AT HIGH PRESSURES required the positive displacing action of conventional reciprocating pumps plus the flexibility of capacity provided by centrifugals. And Aldrich Engineers knew the answer — the Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump.

STEPLESS STRAIGHT LINE CONTROL OF CAPACITY, from zero to rated maximum output, was possible with the "POWR-SAVR". Pump delivery was automatically controlled to suit varying requirements and power consumption became nearly proportional to the rate of output, affording desirable power savings.

SURGE TANKS WERE ELIMINATED, due to the "POWR-SAVR's" ability to meet immediate changing line conditions. This eliminated associated evaporation losses, co-mingling of different batches, and much of the danger of handling highly flammable material. Gone, too, was the need for bypassing to handle excess quantities of pump output.

UPRIGHT DESIGN of the "POWR-SAVR" places discharge valves directly over the plungers and inlet valves at one side. Efficient valve action permits the pump to operate at the high rate of 240 rpm. Another design feature was the use of porcelain plungers, reducing packing and leakage troubles.

THE ALDRICH PUMP COMPANY has been solving the difficult pumping problems of American industry since 1902. We've never turned down a challenge — many of yesterday's tough pumping problems are today routine.

DATA SHEET 65A, describing the Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump will be sent to you on request. Or our representative will be glad to call. Address your request to: The Aldrich Pump Company, 26 Pine Street, Allentown, Pa.

Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump suitable for pumping butane and other light-gravity fluids.

... for your tough pumping problems specify ALDRICH

This machine is ideal for pumping light-gravity fluids at medium and high pressures. It combines features of superior efficiency and positive displacing action of reciprocating pumps with the flexibility of capacity of centrifugal pumps. A unique, reliable mechanism controls the plunger-stroke from zero to rated output without change of speed of power source, providing desired savings in power plus top efficiency.

Typical Applications for the Aldrich-Groff "POWR-SAVR" Pump:

Pipe Line Service	Process Charging
Boiler Feeding	Oil-burner Supply

Write for Data Sheet 65A, describing the features of the "POWR-SAVR" Pump. Or, if you prefer, our representative will be glad to call.

THE ALDRICH PUMP COMPANY

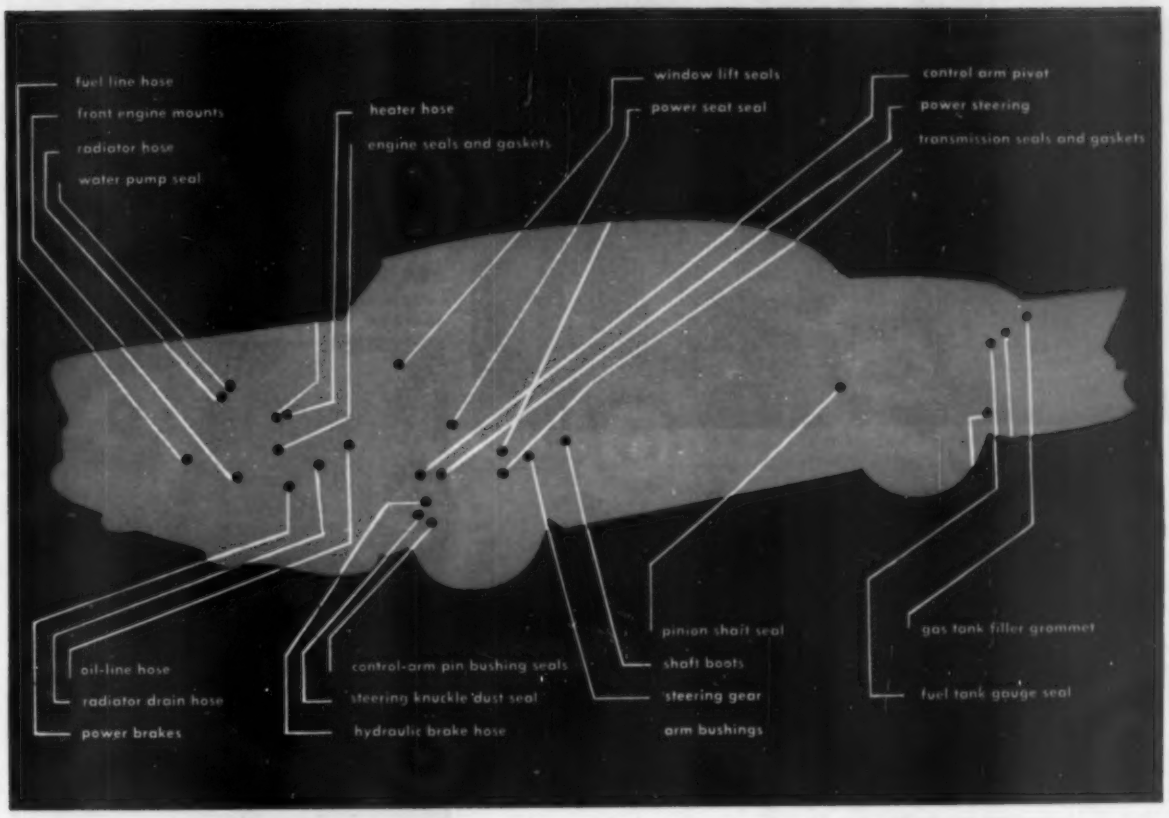
Originators of the Direct Flow Pump

26 PINE STREET

ALLENTOWN, PA.

Representatives in principal cities

Naugatuck Paracril



Paracril...the oil-resistant, nitrile rubber suited to many automotive applications!

Spelled-out above are just a few applications for Paracril, Naugatuck's butadiene-acrylonitrile copolymer. Unequalled in resistance to oils, fuels and organic esters, aromatic hydrocarbons, chlorinated organic liquids and most hydraulic fluids, the Paracrils provide greater tensile strength with increased dimensional stability, high abrasive resistance, unusual low-temperature flexibility, and excellent resistance to oxidation.

Paracril® stocks are fully compatible with most other rubbers and plastic resins... can be calendered, extruded, or molded by standard rubber forming methods... are easily dissolved in solvents to make low-viscosity solutions for cement applications.

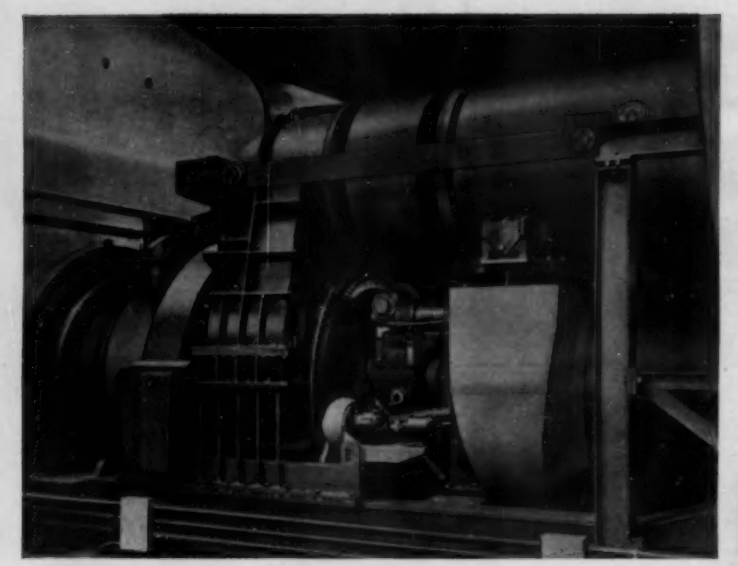
Why not write to us on your company letterhead for application and test data today?

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

US RUBBER

IN CANADA: NAUGATUCK CHEMICALS, Elmira, Ontario • Cable Address: Rubexport, N.Y.
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices



Clark 8500 BHP Gas Turbine for centrifugal compressor, generator or pump drive.

GAS TURBINES + CENTRIFUGAL COMPRESSORS

Only CLARK builds both!

Now you can get centrifugal compressors and modern gas turbines to drive them *exclusively* from one manufacturer . . . Clark.

In addition to saving money and headaches, you'll get proved, matched-performance "packages" specifically designed for continuous trouble free service.

Whether you have a million or a billion cubic feet of air or gas per day to handle at pressures of up to 4500 pounds per square inch, there is a Clark centrifugal compressor and in most cases a matching Clark gas turbine to drive it.

Your nearest Clark representative will be pleased to give you all the facts.

CLARK BROS. CO., OLEAN, N. Y.

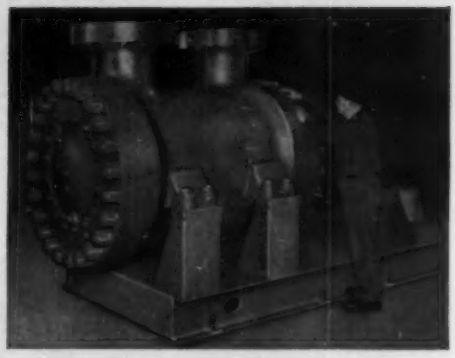
One of the Dresser Industries

Offices in Principal Cities throughout the World

CLARK®

GAS TURBINES
CENTRIFUGAL COMPRESSORS

Clark Barrel Type Centrifugal Compressors for extremely high pressures.



Clark Multi-Stage Centrifugal Compressors designed for process applications.

Clark Centrifugal Pipeline Booster for low ratios and high pressures.

OIL PRODUCTION SUPERVISORS

A major integrated U. S. oil company operating in South America has career opportunities in a rapidly expanding organization for qualified oil production supervisors in production work including (1) well repair, cleanout and workover (2) supervision of 150-200 natural-flow and pumping wells and the gathering and producing facilities of approximately 200,000 B/D of crude oil (3) supervision of pipelaying barge in laying and repairing of offshore gathering lines. Engineering graduates preferred; high school minimum acceptable education. Candidates must have had a minimum of 6-8 years of diversified and progressively responsible oil field production experience. Salary including bonus approximately $14,000-$16,000 depending on qualifications and experience. Liberal employee benefits including home vacations with travel expenses. Send complete resume of personal data and work experience. *Replies held in strict confidence.*

Box 480, Dept. Y-80, New York 19, N. Y.

DRILLING ENGINEERS

A major integrated U. S. oil company operating in South America has career employment opportunities in a rapidly expanding organization for qualified drilling engineers with 4½ to 8 years of experience in the drilling phase of the oil industry. Candidates must be graduate engineers preferably with a mechanical or petroleum engineering degree. Salary including bonus of approximately $14,000-$15,800 depending on qualifications and experience. Liberal employee benefits including home vacations with travel expenses. Send complete personal data and work experience resume. *Replies will be held in strict confidence.* Interviews will be arranged for qualified candidates.

Box 480, Dept. P-80, New York 19, N. Y.

WANTED: ENGINEERING EDITOR

If you are a graduate petroleum engineer between 25-30 years of age with two or three years field experience and want to learn more about the oil industry, make occasional field trips, attend meetings, increase your chances for advancement, contact the industry for information, edit and prepare articles on operations, new developments, methods and timely events, send all particulars about yourself, references, and a photo to: *Mr. Frank Love, Editor-In-Chief,* THE PETROLEUM ENGINEER, *P. O. Box 1589, Dallas 21, Texas.* Writing experience not necessary, although use of a typewriter is helpful. Initial training will be at the Dallas home office. Good starting salary, company benefits and expense account.

UNUSUAL OPPORTUNITIES

Assistant General Superintendent for small progressive Petro-Chemical Plant located on Gulf Coast. Requirements: B.Ch.E. Degree, Minimum 8-10 years diversified experience.

Chief Chemist: Requirements: B.Ch.E. Degree. Minimum of 3-5 years experience including laboratory and process engineering work. Ability to instigate and supervise research work.

Applicants write giving qualifications and minimum salary requirements to:

Great Southern Chemical Corporation
P. O. Box 4166 Corpus Christi, Texas

PETROLEUM ENGINEERS

(South America)

Graduate engineers with experience in drilling, production, reservoir and equipment. Working knowledge of Spanish desirable but not essential.

LUBRICATION ENGINEERS

(West Africa)

Mechanical Engineer's degree and experience in lubrication and petroleum products. Fluent French not essential but working knowledge desirable.

OPERATIONS SUPERVISOR

(West Africa)

Experienced all phases construction engineering concerning marketing petroleum products, i.e., appropriations, terminal layout and maintenance. M.E. or C.E. degree desirable but not essential. Working knowledge French essential.

Liberal Employe Benefit Plans
Salary commensurate with experience

Forward resume of
education and experience to

THE TEXAS COMPANY
Foreign Personnel Office
135 East 42nd Street
New York 17, N. Y.

PETROLEUM ENGINEERS

Experienced graduate engineers for immediate openings in Saudi Arabia and New York City. For engineering work in development, production, drilling, process, and oil and gas engineering on primary and secondary recovery problems.

RESERVOIR FLUID ANALYST

With degree in Physical Chemistry or Chemical Engineering plus 5 years' petroleum production engineering which should include 2 years' study of reservoir fluid behavior.

Salaries commensurate with training and experience. Write outlining personal history and work experience. Please include telephone number.

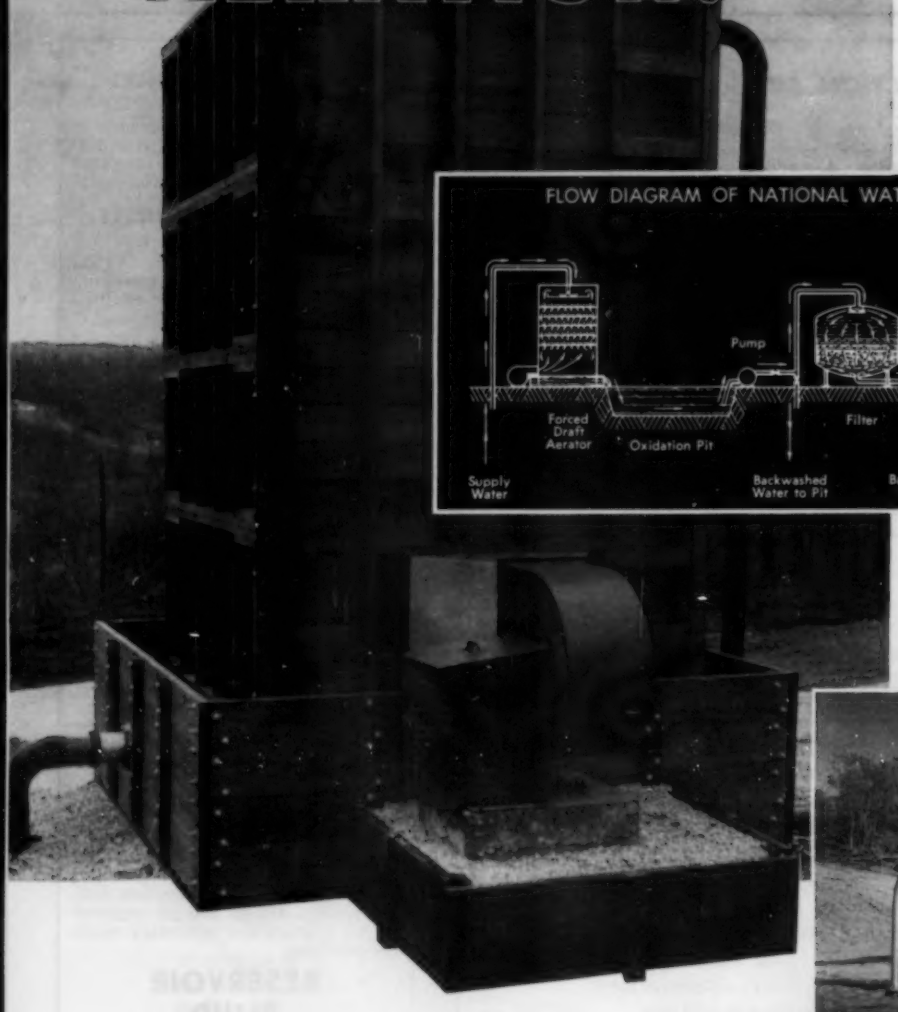
Recruiting Supervisor, Box 117

ARABIAN-AMERICAN OIL COMPANY
505 PARK AVENUE
NEW YORK 22, NEW YORK

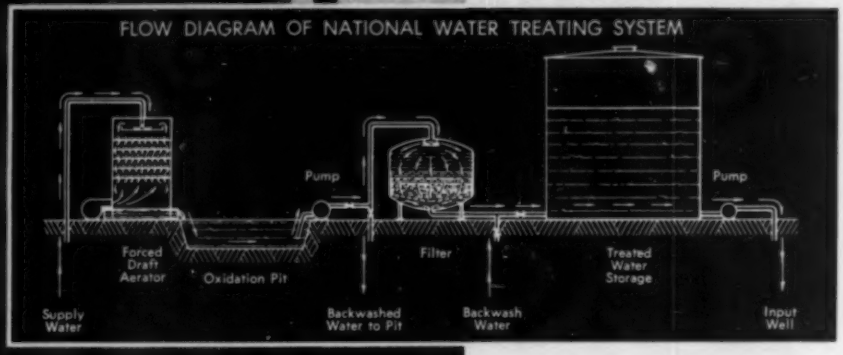
SALES ENGINEER for CALIFORNIA OIL FIELDS

Must have wide experience in selling, servicing, engineering and supervision of the installation of equipment for the treating, dehydrating, separating and handling of Petroleum products. Chemical or Petroleum Engineer preferred. Offshore Production Equipment experience helpful. Give complete details in first letter and salary requirements. *Box 179, % The Petroleum Engineer, Box 1589, Dallas, Texas.*

AERATION!



National Aerator for treating supply water or disposal water in open water system.



Two National Aerators in series with water supply well located north of Tulsa, Oklahoma.

A Part of The . . .

NATIONAL *"OPEN SYSTEM"*

Salt Water Treating

The National forced draft Aerator is fabricated of redwood with reinforced fiber glass distributor and splash trays, to facilitate ease of and reduce frequency of cleaning. Distribution of water from tray to tray assures liberation of water-bound gases which are expelled to the atmosphere by controlling the volume of air introduced at bottom of the Aerator.

Submerged Aerators are also manufactured by National as are complete closed and open water systems.

Our Engineering Department welcomes inquiries concerning your water disposal problems.

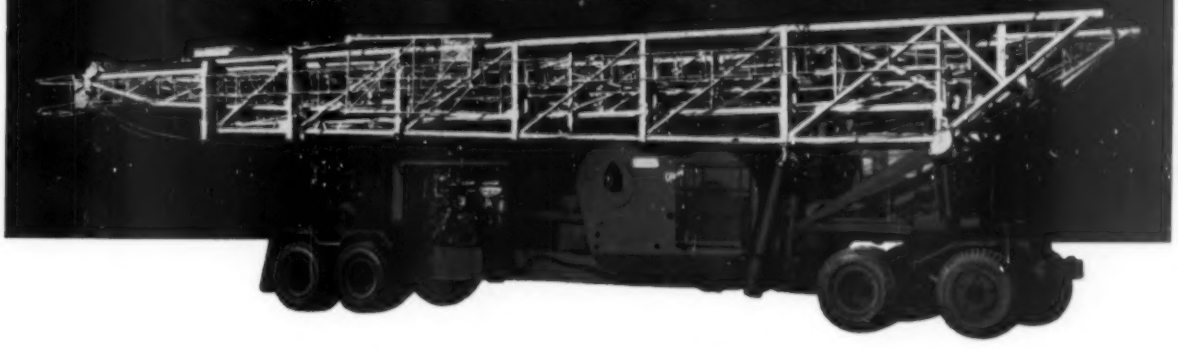
It's a National®

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

DESIGNED FOR WELL SERVICING

...AS FAST ON THE HIGHWAY AS A TRUCK



FRANKS *Clipper*

The Franks Clipper is a unit basically built for servicing – the main job of the unit – but which is also self-propelled, using the drawworks motor for road power.

One feature is that the Clipper heads into location making "spotting" much quicker and easier. The use of outriggers makes the unit more stable and assures operation without ground guylines.

The Clipper moves completely strung-up and is the fastest location-to-location unit, rig-up and rig-down unit on the market. Franks unit is fully field tested. It will pay you to look at a Clipper before you buy.

FRANKS DIVISION
Cabot Shops, Inc.
Box 3218, Whittier Station
TULSA, OKLAHOMA

FRANKS
DIVISION CABOT SHOPS INC
WELL SERVICING AND DRILLING UNITS
TULSA, OKLAHOMA

"ON THE SPOT" FIELD SERVICE

A DIVISION OF CABOT SHOPS, INC.

These are the 4 big reasons why operators get better service from LANE-WELLS PACKERS

1 LONGER LIFE

2 EASY PULLING

3 LEAK-PROOF PACKOFF

4 POSITIVE SETTING

And here are a few of the design and construction features which give these 4 big values:

SLYDEZE dovetailed slips which can't catch or hang up the packer, and don't "freeze" to the cone.

CROSS-CUT wickers which hold firm on hardest casing, without harming the casing.

CONTROLLED-EXPANSION sealing element which springs back to shape upon release, and doesn't "vulcanize" to the casing.

LIFTING LUGS which insure release of the sealing element.

LARGE BY-PASS (in valve-type packers) which gives fast running in fluid.

FULL-DIAMETER mandrel which allows free passage of tools.

Tomorrow's Tools Today!

There's a LANE-WELLS PACKER "tailor-made" to fit *your job—write for complete information.*

LANE WELLS COMPANY

GENERAL OFFICES, EXPORT OFFICE, PLANT • 5610 SO. SOTO ST., LOS ANGELES 58

Los Angeles • Houston • Oklahoma City • Lane-Wells Canadian Co. in Canada • Petro-Tech Service Co. in Venezuela

Of Things To Come . . . In Oil

OFFSHORE ACTIVITY TO RESUME after temporary Supreme Court order not to drill new wells in disputed zone contested by Louisiana and Federal Government. Way out of order left open by both parties making tentative agreements pending outcome of dispute to be heard in Washington this fall. Disputed area lies between the 3⅓ and 10-mile limits, which is currently the most active.

TARIFF ON U. S. CASING IMPORTED TO CANADA in for tough sledding before Tariff Board of Canada, if brief submitted by Canadian Petroleum Association has any effect. Canadian pipe makers want a 22½ per cent tariff, but they offer only welded pipe not suitable for all wells. CPA objects on basis high tariff would impede development.

GAS FIELD PRICES MAY GO UP instead of down in some cases under FPC's new authority to control price of gas sold to interstate pipe lines. FPC said recently that Phillips was entitled to 10 per cent more than it was charging, based on study of books.

OIL WELL COMPLETIONS IN TEXAS headed for all-time high if first half-year is any indication. Texas Railroad Commission reports 8000 oil well completions up to mid-June, nearly 1000 more than same time last year. Rate is about 360 oil well completions each week.

OIL IMPORT FORMULA in for close study by Cabinet Committee on Fuels Policy. Formula set by Flemming limits imports to 16.6 per cent of U. S. production; objectors claim imports have increased to 22 per cent. Texas Railroad Commission has criticized import increases in establishing oil production allowables for July.

He's Your Man... 24 Hours Per Day!

Around the clock service... Eastman Engineers are ready to serve you any time — anywhere. Directional Drilling, Sidetracking and Oil Well Surveying is our business. ¶ Since 1930, Eastman research has contributed much to the advancement and success of the oil industry by introducing and perfecting outstanding developments in deflecting tools and techniques used in directional drilling, sidetracking, and sub-surface surveying of oil well bore holes. ¶ An Eastman Engineer equipped with the knowledge of Eastman Services and Eastman produced instruments and tools can become the means of success you desire in your well.

DIRECTIONAL DRILLING
Eastman
OIL WELL SURVEYS

EASTMAN OIL WELL SURVEY COMPANY

LONG BEACH • DENVER • HOUSTON

Export Sales and Service:
EASTMAN INTERNATIONAL COMPANY
P. O. Box 1500 • Denver, Colorado, U. S. A.

Drill Collar value is not proven on the rack . . .

New Drill Collars on a rack can be very deceptive—perfect threads, both in form and taper, shiny paint on the outside and perfectly straight from pin to box.

Each is important, but drill collars on the rack haven't yet made one contractor a penny. Not until a drill collar is in the hole will it be of any value, and not ***then*** unless, in addition to the obvious features, it has other superior qualities which do not show in the drill collar on the rack:

- ✓ *Special steel, formulated and heat treated to resist wear and fatigue failures.*
- ✓ *Special overall stress relieving to guarantee perfect balance and reduce drill string vibration.*
- ✓ *Special engineering and manufacturing techniques.*
- ✓ *The finest record of drill collar performance in the field today.*

These superior qualities are present in every American Iron Drill Collar . . . the obvious, visible on the rack . . . *ALL proven in the hole!*

Available through your supply store.

AMERICAN IRON & MACHINE WORKS CO. INC. OKLAHOMA CITY

Another AMF Product PETROLEUM EQUIPMENT

AMERICAN IRON & MACHINE WORKS COMPANY, INC.
518 North Indiana Avenue • Oklahoma City, Oklahoma
Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

Double-Barreled SAVINGS . . .

when you use

MARTIN PLUNGERS

1 SAVE ON PLUNGER COSTS

One Martin Plunger will make many long runs, with only the rings being replaced. A set of rings costs only one fourth as much as a new plunger. Thus it is easy to figure the savings on the plunger alone.

2 SAVE ON BARREL COSTS

Metal to metal wear is eliminated. The resilient rubber & duck rings are so much easier on the barrel surface that barrels usually last several times longer. Here too is an important item in pump costs.

MORE BARRELS IN THE TANK TOO because of better seal, freer travel in the barrel and longer runs. AVAILABLE for your pump and your well, regardless of diameter, or depth or well condition. Get catalog No. 4 and read how to make selection and installation.

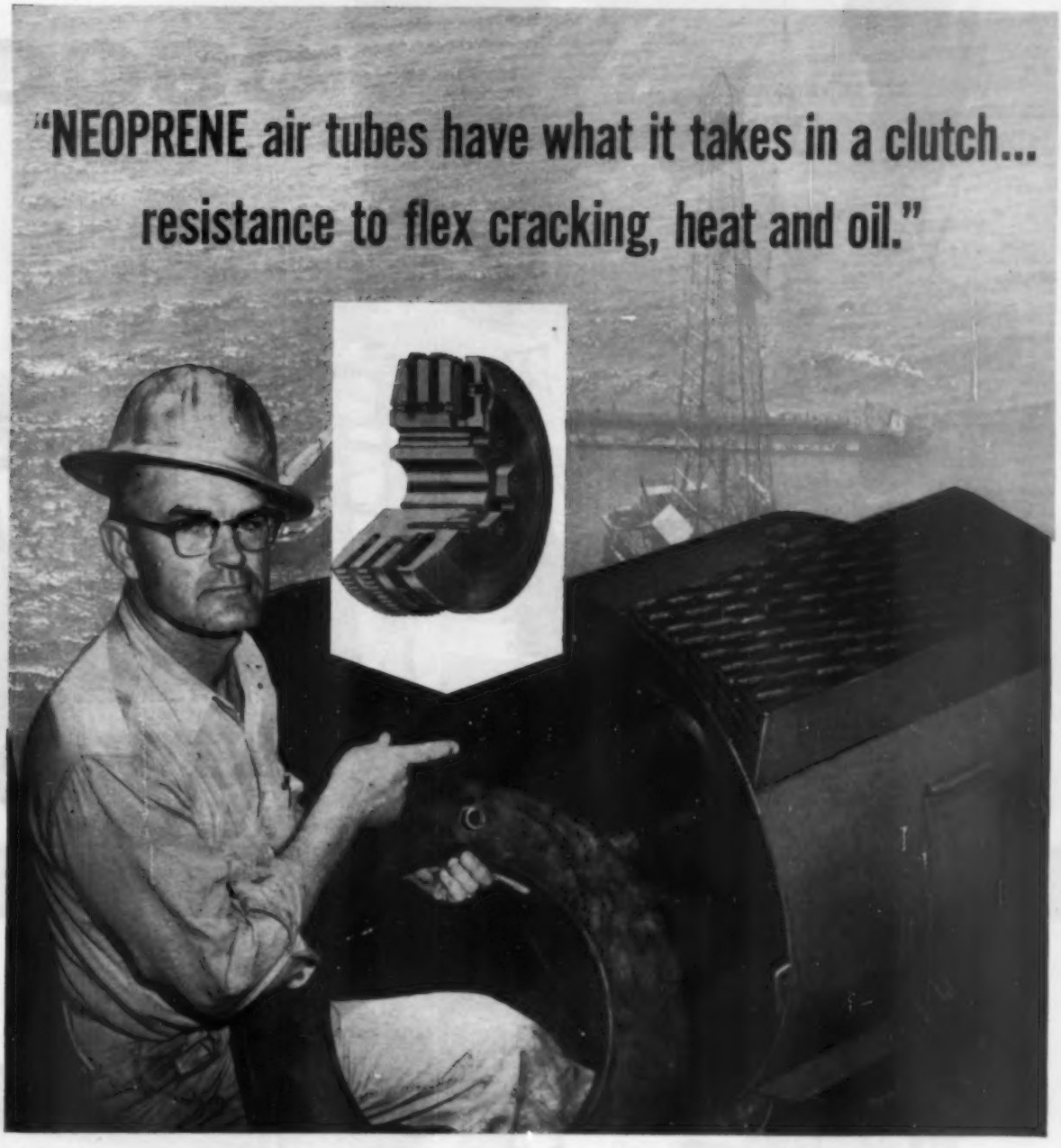
MARTIN PLUNGERS ARE SOLD THRU SUPPLY COMPANIES

JOHN N. MARTIN

Manufacturer

9 W. BRADY • TULSA, OKLA.

"NEOPRENE air tubes have what it takes in a clutch... resistance to flex cracking, heat and oil."



Those are the words of Mr. E.F. Cain, toolpusher on the Rebstock and Reeves 2-R Drilling Barge #1, Lake Washington area, south of New Orleans, La.

He goes on to say, "The neoprene air tube has a tough job . . . withstanding the heat buildup of the clutch plate and the flexing at each stop and start in this rotary clutch. Besides that, our compressed-air system is equipped with an air-stream lubricator to lubricate valves and control devices, and the air tube must stand up under contact with the oil mist. Neoprene's superior resistance to heat, oil and constant flexing helps make this rotary clutch and 11 other Wichita Air Tube clutches on this Wilson Rig practical."

Right you are, Mr. Cain. Earlier designs of these clutches, using natural-rubber tubes, required excessive servicing. The natural-rubber tubes became tacky from oil exposure; they swelled, and the inside surfaces tended to stick together. When rayon-reinforced neoprene air tubes were adopted, the problem was overcome.

Many service problems in the oil field are solved by neoprene: Hose, packings, drill-pipe protectors and piston rubbers are a few of the applications in which neoprene offers long life and outstanding resistance to deterioration. Neoprene resists sunlight, weathering and aging . . . oil and grease . . . abrasion and flex cracking—just about everything encountered on the rig. So when you're buying, be sure to specify NEOPRENE.

FREE! THE NEOPRENE NOTEBOOK. Regular issues give on-the-job reports about neoprene. Write: Du Pont, Elastomers Div., Wilmington 98, Delaware.

NEOPRENE

The rubber made by Du Pont since 1932

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

CSCO
HIGH RUGGED TERRAIN..TO
SEA LEVEL SWAMPLAND
ARCTIC COLD...TO
DESERT HEAT

PUMPING ENGINES

...wherever Oil is produced!

Under any operating conditions—Cold or Hot—Dry or Humid—Isolated or Urban Areas—CSCO Pumping Engines Need no Special Equipment and are Easiest to Maintain

Only CSCO Engines have ALL 4 of these important features:

EASY AND SAFE TO START...The combustible mixture is allowed to charge the cylinder during free cranking against no compression.

EASY TO SERVICE... There's no need to stop a CSCO to check or add oil . . . or water. Less shutdown for servicing.

EASY TO REPAIR... CSCO parts needing repair or attention can be removed with a minimum of disturbance of adjacent parts or assemblies.

SMOOTH, STEADY OPERATION... Flywheel inertia provides peak power while oil damped governor holds throttle steady — permitting engine to average demand, up to full capacity.

CSCO Pumping Engines are available through supply stores other than Continental

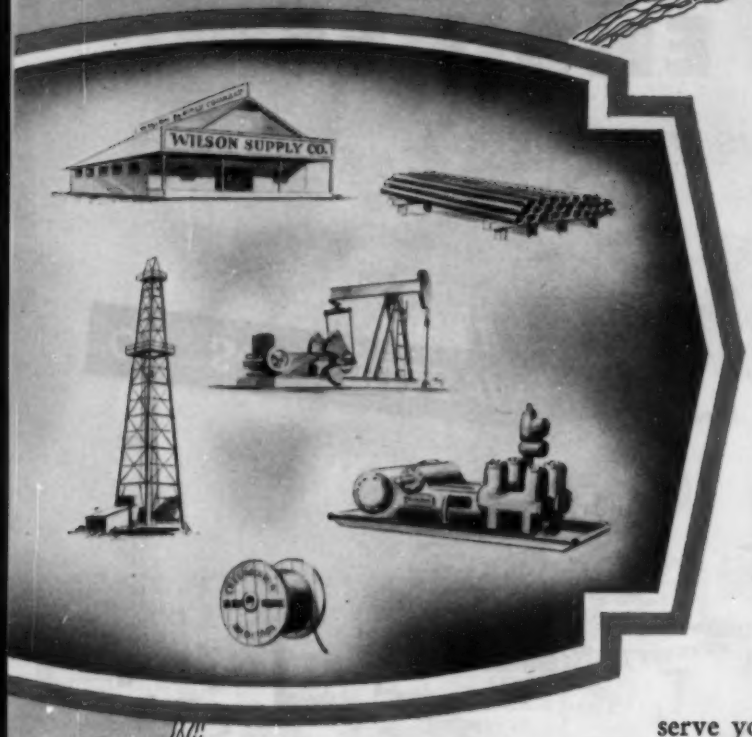
CONTINENTAL

Serving the Oil and Gas Industries

CONTINENTAL SUPPLY COMPANY

A Division of The Youngstown Sheet and Tube Company
General Offices: DALLAS, TEXAS
Representatives in All Principal Oil Fields of the World

The Petroleum Industry... Since 1859 Helping Make America Great



WORKING for YOU

—18 stores—with men and supplies—located to best serve you in Texas and Louisiana.

—'Round the clock' service ready to meet your needs with

"WHAT YOU WANT—
WHEN YOU WANT IT."

WILSON SUPPLY CO

1301 CONTI ST., HOUSTON, TEXAS

BRANCH STORES

TEXAS: Alice, Corpus Christi, Victoria, McAllen, Bay City, Columbus, Barbers Hill, Liberty, Beaumont, Kilgore, Sherman, Odessa. LOUISIANA: Lake Charles, New Iberia, Houma, Harvey, Shreveport.

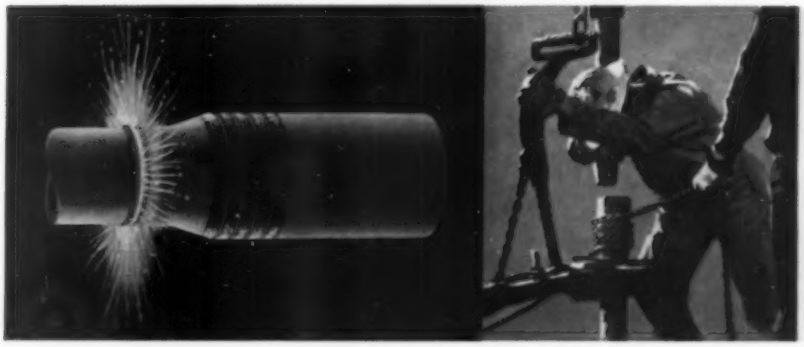
SALES OFFICES

DALLAS · SHREVEPORT · SAN ANTONIO
TULSA · NEW ORLEANS · LAKE CHARLES
CORPUS CHRISTI · MIDLAND

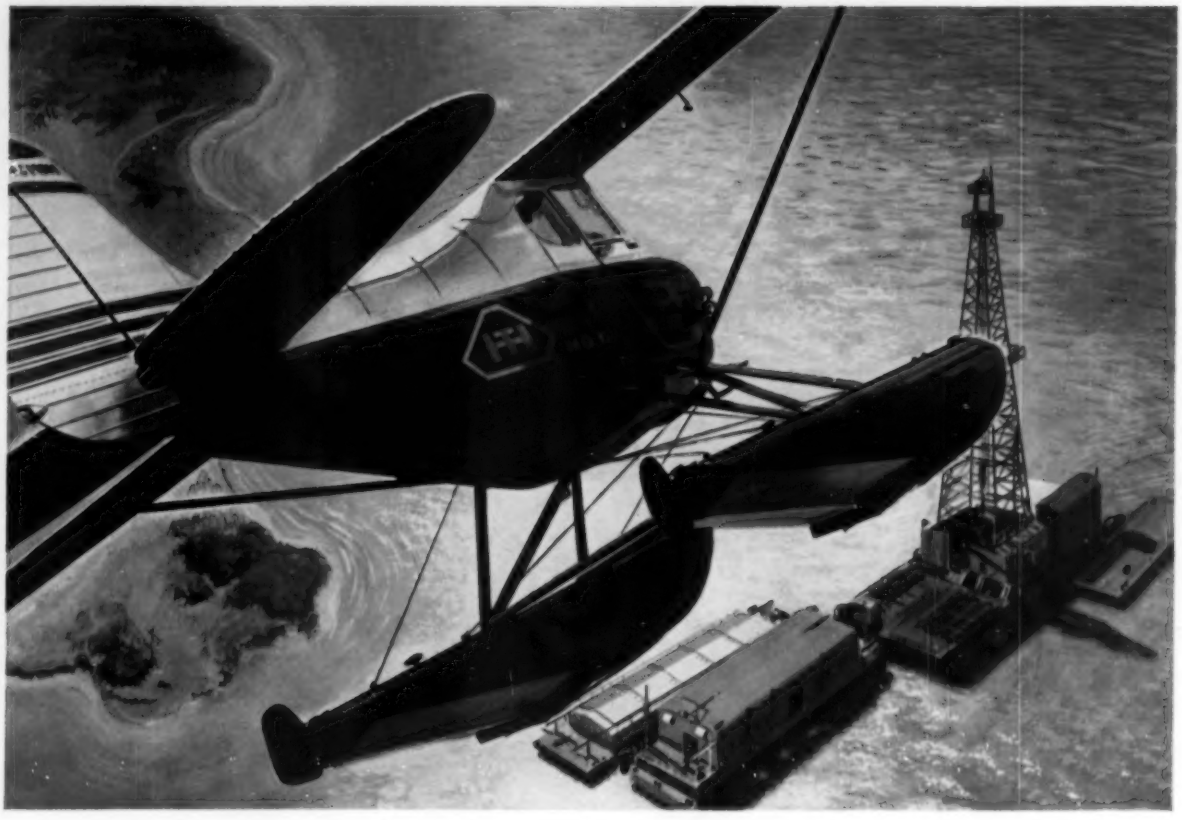
• drilling in remote areas calls for "Flash-Weld"

When your rig is isolated, like the one pictured here, you appreciate the *dependability* and *economy* of a drill stem that has been unitized with "Flash-Weld" tool joints. Out there it is doubly important to avoid the delays and extra cost of changing joints.

For that very reason, operators... in increasing numbers ...are relying on "Flash-Weld" — the joints that last the life of your drill stem — *don't have to be replaced!* HUGHES "Flash-Weld" joints have been proved on more than 35,000,000 feet of drill pipe.



FLASH-WELD
A DEVELOPMENT
OF
HUGHES
TOOL COMPANY
HOUSTON, TEXAS



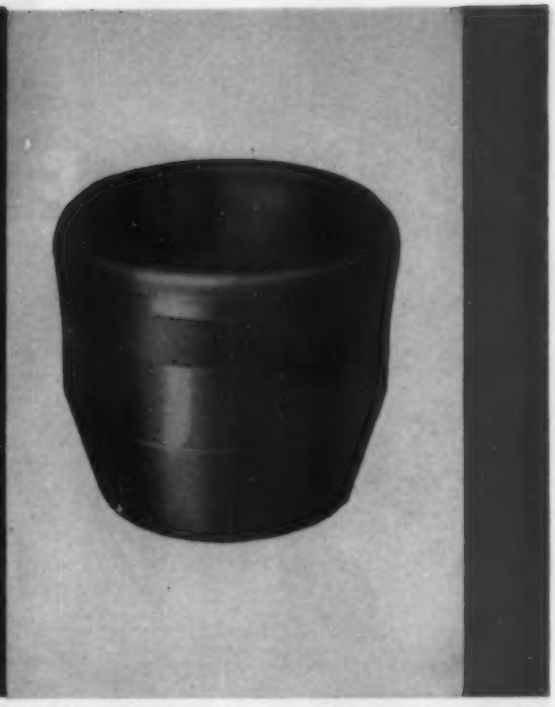
We cover the "waterfront"

In rendering an *industry-wide* service, the more than 450 members of the Hughes sales and service organization cover the drilling "waterfront." That includes the remote and out-of-the-way places, as well as every active drilling area in the United States and Canada.

And what is more, bit deliveries are made to your rig... *ahead of time!* Why? Because the Hughes sales and service organization, working closely with the drilling industry, determines ... *far in advance* ... the bit requirements of each field and wildcat area ... thus assuring that the right sizes and types of bits will be available when needed.

PULL A VACUUM AND SWAB THE WELL CLEAN

with GUIBERSON GW CUPS



Save time.. save money.. save *fluid*.. with GW cups.. with Casing Swabs — products of Guiberson's more than a third century's experience serving the oil industry.

GW cups assembled on famous Guiberson Casing Swab

If you want to *swab* — not just agitate — flexible GW cups on the Guiberson Casing Swab will pull every drop. They hug the casing wall — provide automatic seal and controlled pipe contact — pull a vacuum and clean the well!

Precision molded in Guiberson's own rubber plant from special abrasion resistant compound, GW cups take up their own wear. They are unexcelled in rough or mixed casing strings and for unloading shallow wells. Won't down-swab or hang on casing collars. Interchangeable on the famous Guiberson Casing Swab.

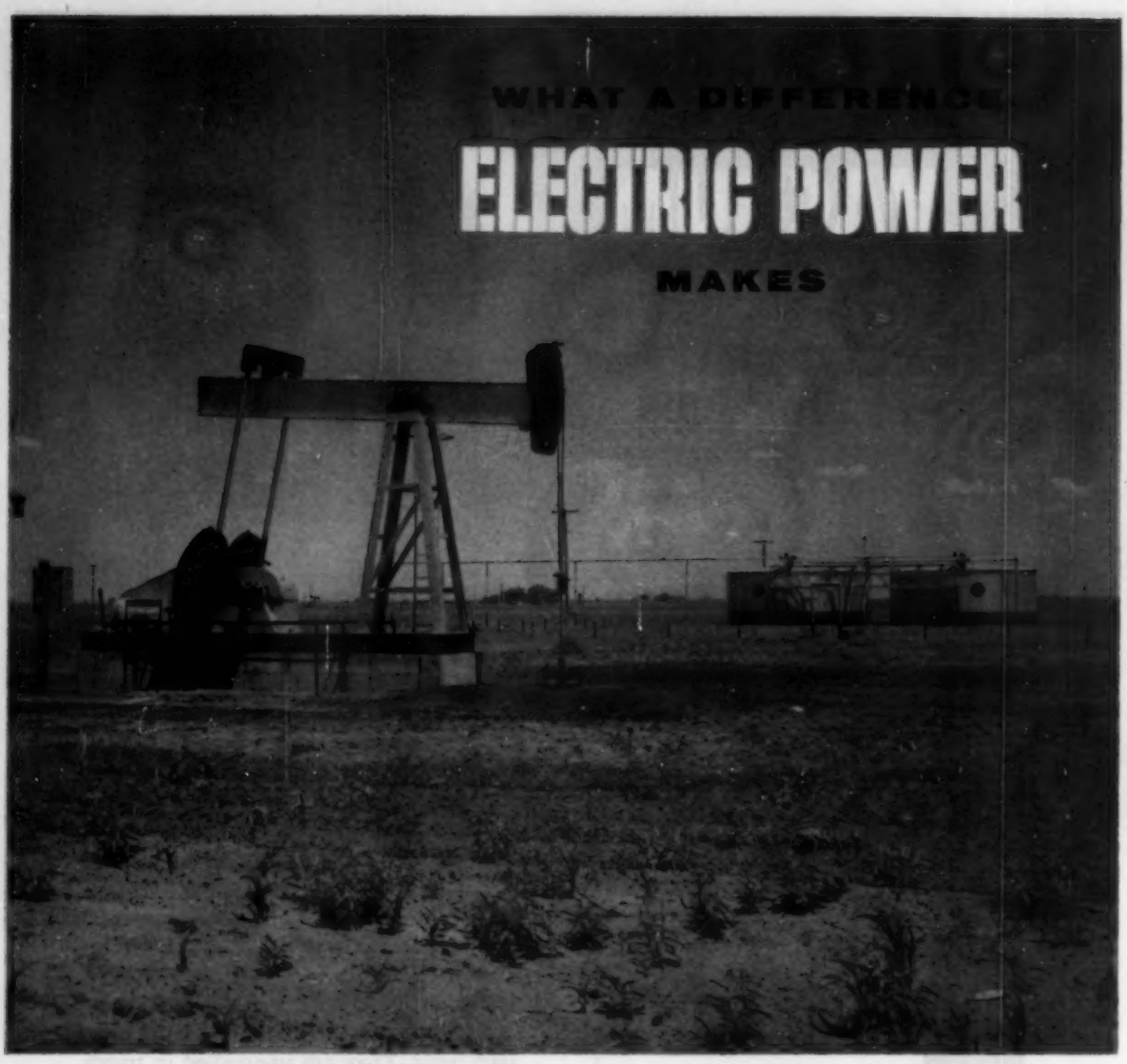
THE

GUIBERSON

CORPORATION

ESTABLISHED 1919 • DALLAS, TEXAS, U. S. A.

Sold By Leading Oil Field Supply Stores Everywhere



It's EFFICIENT and ECONOMICAL

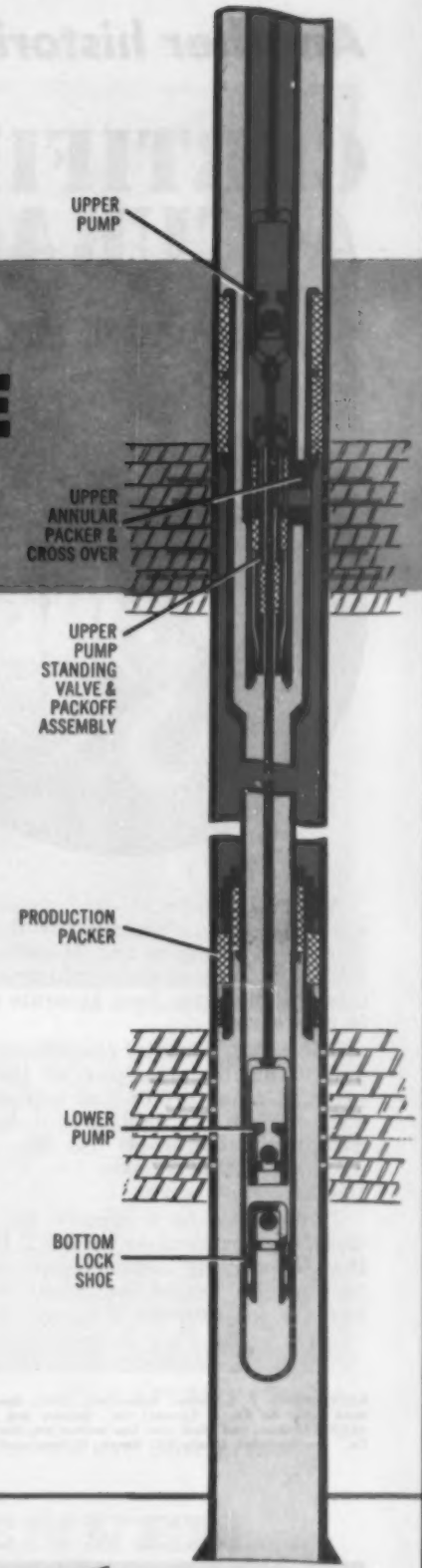
Regardless of the pumping situation... The swing is to Electric Power for the job. In the past 2½ years there has been a steady increase of over 11% in Electrified pumping wells. The reason? Because your Utility Electric Power Companies have done more to advance engineering practices which pave the way for this progress and to provide more dependable and efficient power service when and where it is needed. Next time you specify Power... specify Low Cost Purchased Electric Power.

WRITE PETROLEUM ELECTRIC POWER ASSOCIATION, P. O. BOX 2771, DALLAS, TEXAS, OR CALL THE SALES ENGINEER OF YOUR LOCAL UTILITY ELECTRIC POWER COMPANY — NOW

Produce one or both formations with

EMSCO

D+B OTIS TWO-ZONE EQUIPMENT



through the same well bore without co-mingling the fluids

– backed by many years of research, development, field testing and experience. All sub-surface pumping equipment can be retrieved on the rod string. Production from either pay can be accurately controlled through the use of a pump overload valve.

Check these 7 features made possible only by the exclusive "Removable Sub-Surface Choke" installed in the D + B Otis Crossover:

1. Either or both zones can be pumped or flowed independently of the other.
2. With D+B cross-over assembly in the tubing string, operator can install two-zone pumping equipment if one or both zones ceases to flow.
3. In flowing wells, either or both zones can be acidized and/or swabbed independently of the other.
4. Certain work-over and remedial operations can be performed through this equipment without removing the tubing.
5. Bottom hole temperature and pressure tests of either zone can be taken independently of the other.
6. Pump or swab potential tests of either zone can be taken independently of the other.
7. In flowing wells, tubing and packers do not have to be pulled to run either or both pumps.

On new installations, D+B will furnish, at no additional cost to the customer, capable and experienced personnel to properly install the D+B Otis Two-Zone Equipment. *Call your nearest Continental or D+B store for new illustrated bulletin.*

CONTINENTAL
Serving the Oil and Gas Industries

CONTINENTAL SUPPLY COMPANY
A Division of The Youngstown Sheet and Tube Company
General Offices: Dallas, Texas
Representatives in all principal oil fields of the world

EMSCO
TRADE MARK
QUALITY IS OUR PRODUCT

D+B DIVISION
EMSCO MANUFACTURING COMPANY
Garland, Tex. • LOS ANGELES, CALIF. • Houston, Tex.
General Sales Offices: Dallas, Texas

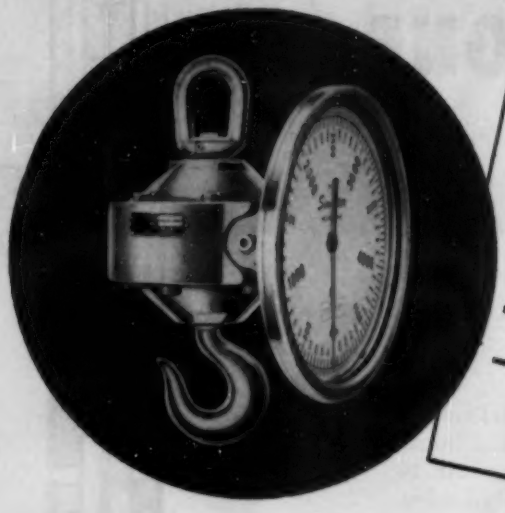
D+B

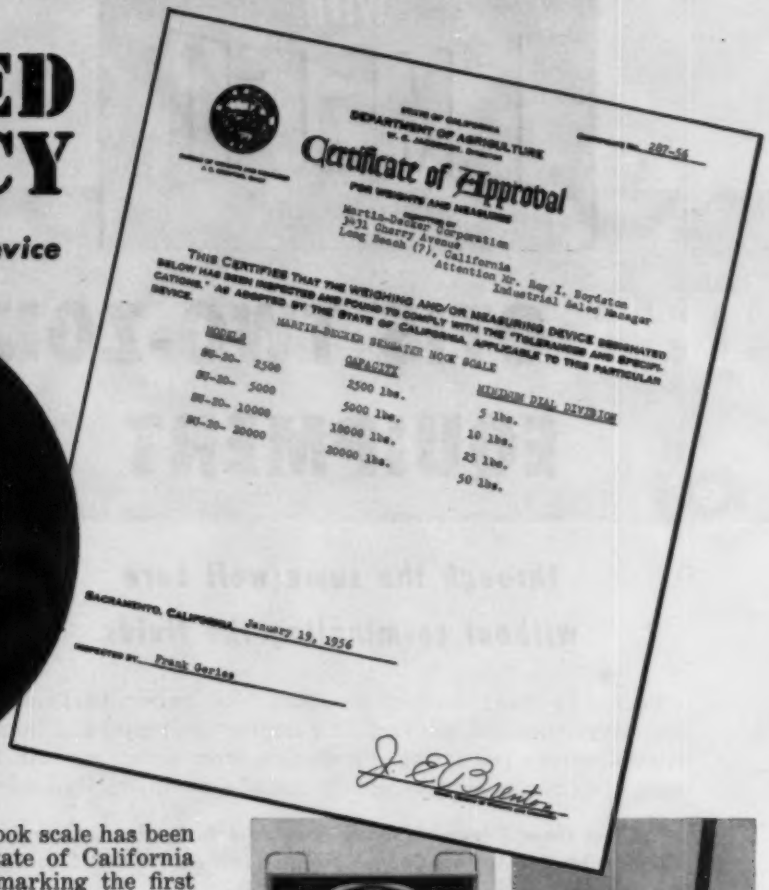
L-602

Another historic *first* by Martin-Decker...

CERTIFIED ACCURACY

in a hydraulic weighing device





STATE OF CALIFORNIA
DEPARTMENT OF AGRICULTURE
H. G. ANDERSON, Director

Certificate No. 287-56

Certificate of Approval

FOR WEIGHTS AND MEASURES

Issued to
Martin-Decker Corporation
3431 Cherry Avenue
Long Beach (7), California
Attention Mr. Ray I. Boydston
Industrial Sales Manager

THIS CERTIFIES THAT THE WEIGHING AND/OR MEASURING DEVICE DESIGNATED BELOW HAS BEEN INSPECTED AND FOUND TO COMPLY WITH THE "TOLERANCES AND SPECIFICATIONS," AS ADOPTED BY THE STATE OF CALIFORNIA, APPLICABLE TO THIS PARTICULAR DEVICE.

MODEL	CAPACITY	MINIMUM DIAL DIVISION
SU-20- 2500	MARTIN-DECKER SENSATER HOOK SCALE	
SU-20- 5000	2500 lbs.	5 lbs.
SU-20- 10000	5000 lbs.	10 lbs.
SU-20- 20000	10000 lbs.	25 lbs.
	20000 lbs.	50 lbs.

SACRAMENTO, CALIFORNIA, January 19, 1956

INSPECTED BY: Frank Gerics

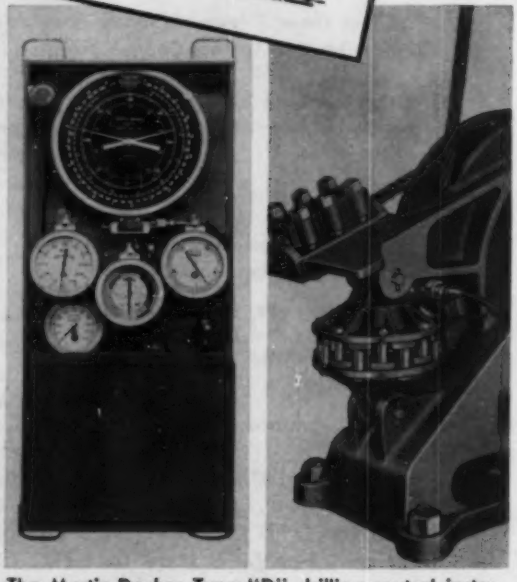
J. E. Brenton

Martin-Decker's SU-20 Sensater hook scale has been approved for certification by the State of California Bureau of Weights and Measures, marking the first time that a heavy-duty industrial weight indicator of this kind has ever been accurate enough to be certified *in any state.*

The SU-20 Sensater operates on the same mechanical and hydraulic principles as the E-80 Sensater, the pressure transformer that actuates the Martin-Decker Type "D" or "E" drilling-control instrument. Both the SU-20 and the E-80 use Martin-Decker's patented diaphragm that strokes like a piston — but with no friction whatsoever.

It may not be necessary that an oilwell drilling-control instrument be certified. But, if the time comes that the drilling industry demands proof of the accuracy of the weight indicators it uses, Martin-Decker has the instruments that will pass the test.

DISTRIBUTORS: T. C. Cullen, Bakersfield, Calif., Reed Roller Bit Co., Houston, Texas; Reed Roller Bit Co. of Canada, Ltd., Calgary and Edmonton, Alberta. Martin-Decker weight indicators and Ideal wire line anchors are also sold through The National Supply Co., The National Supply Co. Export Division and other recognized supply houses.



The Martin-Decker Type "D" drilling-control instrument derives its accuracy from the signals transmitted by the supersensitive E-80 Sensater installed as an integral part of the Ideal wire line anchor.

MARTIN-DECKER CORP.

HOME OF THE WEIGHT INDICATOR — LONG BEACH, CALIFORNIA

Gardner-Denver . . . Serving the World's Basic Industries

Compressors for air drilling

Mud pumps for deep holes

In step with oil industry progress
Gardner-Denver quality equipment

Gas booster compressors

Well servicing pumps

Air for pipe line testing

Air hoists for the rig

"Quad-dril"® for pipeline rock work

Full line of water flood pumps

In drilling . . . producing . . . pipelines . . . Gardner-Denver equipment leads the way! Send for details.

GARDNER - DENVER

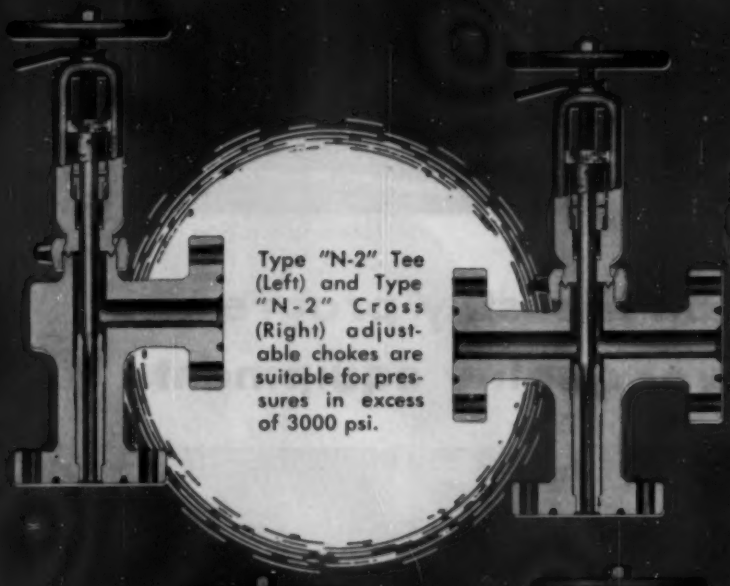
THE QUALITY LEADER IN COMPRESSORS, PUMPS, ROCK DRILLS AND AIR TOOLS
FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

Gardner-Denver Company, Quincy, Illinois — Gardner-Denver Export Division, 233 Broadway, New York 7, N. Y.
In Canada: Gardner-Denver Company (Canada), Ltd., Winnipeg—Edmonton—Toronto

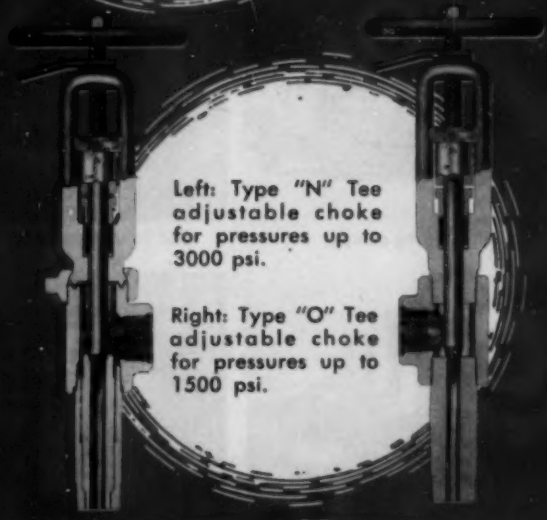
Oilfield Offices:
Dallas, Houston, Tulsa, St. Louis, Los Angeles, New York, Pittsburgh, Denver, New Orleans, San Francisco, Kansas City

O·C·T offers a complete

ADJUSTABLE CHOKES



Type "N-2" Tee (Left) and Type "N-2" Cross (Right) adjustable chokes are suitable for pressures in excess of 3000 psi.



Left: Type "N" Tee adjustable choke for pressures up to 3000 psi.

Right: Type "O" Tee adjustable choke for pressures up to 1500 psi.

Type "JW" Tee adjustable choke for pressures up to 10,000 psi.

ALL SIZES

0.0273" to 2¼"

ALL PRESSURE RATINGS

1,500 psi to 30,000 psi

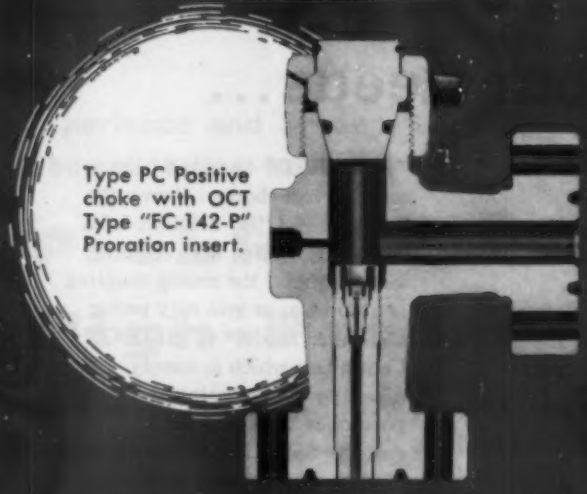
line of chokes... and every one is the best of its kind!

OCT Type "FC-25" Positive flow beam.

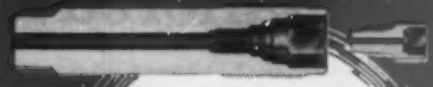
OCT Type "FC-140" Cage nipple and flow bean.

POSITIVE CHOKES

OCT makes a complete line of cross and tee choke fittings in all popular sizes and all pressure ratings, as well as a complete line of cage nipples, flow beans, and proration inserts. Most choke fittings will accommodate either positive flow beans or adjustable choke assemblies. This interchangeability reduces the inventory of parts required to service wells in a given field.



Type PC Positive choke with OCT Type "FC-142-P" Proration insert.



OCT Type "FC-142-P" Proration insert.

ALL parts of OCT Chokes are carefully made of materials best suited to the requirements of the well. Precision machining assures maximum safety as well as interchangeability of parts.

ALL MATERIALS

OCT Chokes are made in a complete range of materials from special analysis steel for general duty to tungsten carbide, monel or stainless steel for "problem" applications.

O·C·T

OIL CENTER TOOL CO.

P. O. Box 3091, Houston, Texas

Export Representatives: Sterling Areas — Le Grand, Sutcliff & Gell, Ltd., Rochester, Kent, England. South America—East West Oiltools, C. A., Del Lago Hotel, Maracaibo, Venezuela. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.

Baker Model "H-20"
Casing Centralizer
Product No. 9112

a size and type...

Model "H-20"
(2" Bowed Height)
Product No. 9114

Model "H-20"
(2½" Bowed Height)
Product No. 9113

Model "H-15"
(1½" Bowed Height)
Product No. 9115

Model "H-20"
(2" Bowed Height)
Product No. 9112

"TAILORED" to your needs because Baker Casing Centralizers are made with bowed height ("effective reach") of springs from 1¼" to 5"—for a range of open hole diameters from 5⅜" to 26½"—and to run on casing sizes from 4½" to 16". It's easy to see that the *exact* size is available to fit *your* casing and provide effective centering in the greatest practical range of open hole diameters.

"tailored" to your needs...

Baker Model "G-20"
Casing Centralizer
Product No. 910-G

Model "G-20"
(2" Bowed Height)
Product No. 910-G

Model "G-15"
(1½" Bowed Height)
Product No. 910-G

Model "G-15"
(1½" Bowed Height)
Product No. 910-G

"TAILORED" to your wishes, and you can choose between the Baker Model "H" HINGE-LOK Centralizer which is closed and locked around the casing coupling or stop ring—or you may prefer the Baker Model "G" SLIP-ON Centralizer which is merely slipped over the casing and positioned with stop rings.
Ask the Baker representative about "Protective" primary cementing using Baker Casing Centralizers in combination with Baker Wall Scratchers and Baker Cementing Shoes and Collars.

for better cementing

One of the partners in
BAKER "Protective" Cementing

Baker Flexiflow Fill-Up Collars and Shoes
Baker Casing Centralizers
Baker Wall Scratchers

BAKER
CASING CENTRALIZERS

BAKER OIL TOOLS, INC. HOUSTON • LOS ANGELES • NEW YORK

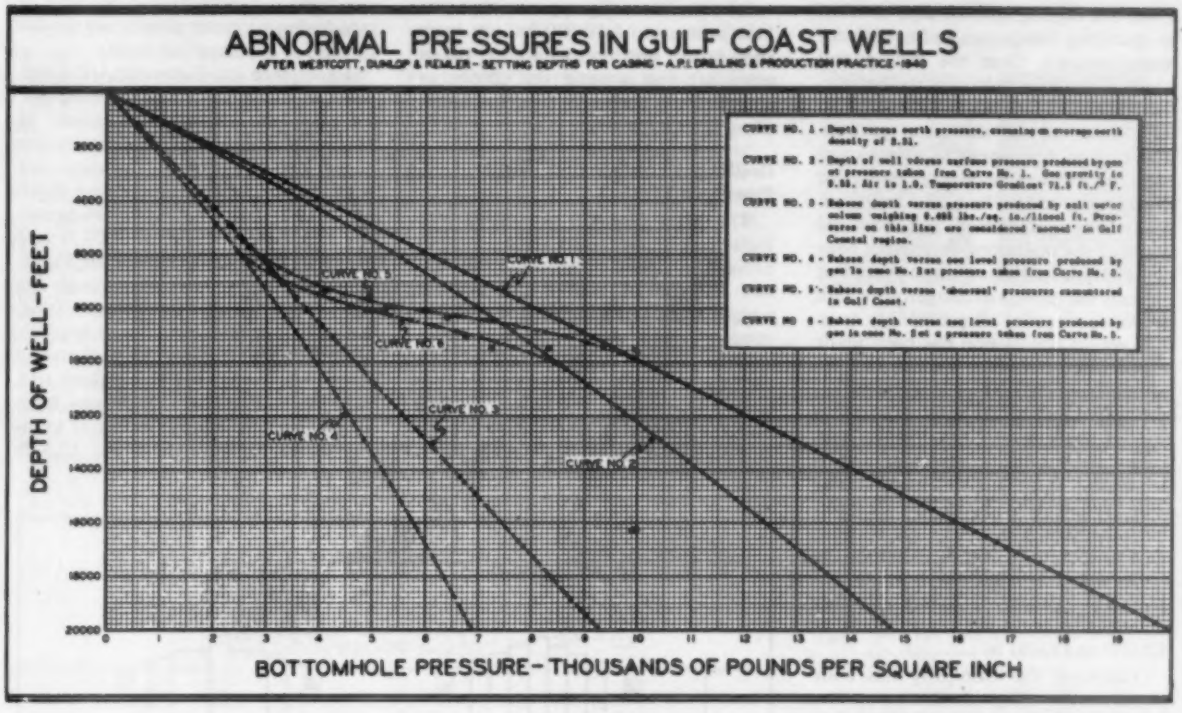

ABNORMAL PRESSURES IN GULF COAST WELLS
AFTER WESTCOTT, DUNLOP & KEMLER - SETTING DEPTHS FOR CASING - A.P.I. DRILLING & PRODUCTION PRACTICE - 1940
DEPTH OF WELL - FEET
BOTTOMHOLE PRESSURE - THOUSANDS OF POUNDS PER SQUARE INCH
CURVE NO. 1
CURVE NO. 2
CURVE NO. 3
CURVE NO. 4
CURVE NO. 5

FIG. 1. **Well pressure curves for Gulf Coast Wells.** Curve No. 3 is the normal pressure gradient; Curves 4 and 5 are abnormal.

Experience and Study Show Solution to . . .

Problems In Completing High-Pressure Gas Wells

For one 15,000-ft well, 970 tons of casing and tubing costing $320,000 were use to control 10,000 psi pressures

J. M. Tharp and J. E. Bailey
Tidewater Oil Company, Houton, Texas

THE experience and observation by Tidewater in development and production of gas with surface pressures in the 10,000 psi range result in the following conclusions:

1. Surface pressures of 10,000 psi are here and surface pressures of 15,000 psi will be encountered in the foreseeable future.

2. The greatest danger in drilling into reservoirs of this pressure range is on the discovery well. Pressure gradients are no higher than has been experienced by the industry for several years and for which mud, drililing equipment and drilling practices have been developed once the optimum setting depth of protective casing strings has been determined.

3. Steel and connections for tubular goods are available for containing 10,000 psi plus surface pressures with adequate safety factors. The problem is in inspection methods to detect defective or substandard material.

4. Corrosion is serious and must be mitigated to insure against material failure.

5. Wellhead equipment is availabie for working presures of 15,000 psi.

6. There is a field for new developments in surface and subsurface safety controls.

7. Waxing problems can be expected in condensate from extremely high pressure resevoirs.

High pressures being encountered in deep gas reservoirs along the Gulf

Coast are causing considerable concern to operating companies and equipment manufacturers. Over the last several years, there have been reports that surface pressures in excess of 9000 psi were observed for short test periods. The lack of equipment to safely complete the well has made it necessary for the operator to kill the well. Due to improvement in equipment and increased nerve of the operators, there have been completions in the past three years that indicate the reports of dangerously high pressures were in all probability true. One recent completion has been made with a shut-in surface pressure of approximately 10,000 psi, and another well was reported to have indicated a flowing pressure of 12,000 psi on test. One operator has completed, and is producing, 9 wells with shut-in tubing pressures of 8800 to 9150 psi. Completion depths of these wells are between 13,500 ft and 14,500 ft. Another operator has completed, and is producing, 16 wells with shut-in tubing pressures of 8000 to 9000 psi from depths of 12,000 to 13,000 ft.

Tidewater Oil Company has completed three wells with shut-in surface pressures of approximately 9500 psi in the Southdown Sand of the Hollywood Field at Houma, Louisiana, from a depth of approximately 14,500 ft. The first well successfully completed, the Southdown Sugars No. 2, produced over two billion cubic feet of gas in 9 months without difficulty before it was shut-in and loaded with mud. The second well, the Elfert No. 1, produced one month before a tubing and casing failure resulted in loss of the hole. The third well, Southdown Sugars No. 3, was left shut-in and loaded with mud after perforating. The decision to not produce this well, as well as the decision to kill Southdown Sugars No. 2, was occasioned by the tubular goods failure on the Elfert No. 1.

These extremely high pressure wells that have been completed and produced have all been from depths shallower than 15,000 ft to date. The deeper the completion depths, the higher the surface pressure for a given pressure gradient. Fig. 1 shows the relationship of surface and bottom-hole pressures to depth for a normal Gulf Coast pressure gradient of .465 psi per ft and a pressure gradient of 1.00 psi per ft, which is equal to earth pressure assuming an average earth density of 2.31. One well in South Louisiana, which has been well publicized, set the world drilling depth record at 22,570 ft and very possibly could lower the world producing depth record by 3000 or 4000 ft. (See P.E., May, 1956. Well producing from 21,443 ft, 3850 ft below previous record.)

It becomes readily apparent that surface pressures of 10,000 psi are here, and surface pressures of 15,000 psi or more are just around the corner as progressively deeper drilling continues along the Gulf Coast.

Drilling Problems in High Pressure Wells

The main problem in drilling into high-pressure reservoirs is the design of protection casing strings that will permit the use of mud with sufficient weight to hold the pressures and not rupture some upper formation also exposed to the open hole. This is a serious problem in the rank exploratory wells where pressures to be encountered and the depths at which they are located are unknown. Once an exploratory well is successfully completed, a safe casing program usually can be designed for development wells.

Experience of Tidewater Oil Company in discovering and partially developing the Southdown Sand at Houma is an example of this protection casing design problem. The discovery well made normal progress to a depth of 14,356 ft after having set 16-in casing at 288 ft, 10¾-in. at 3000 ft and 7-in at 12,639 ft as shown on Fig 2. The 7-in. casing was set through the newly discovered Krumbhaar Sand, which had normal pressure at approximately 12,500 ft. Since the well proved to be ideally located for a deep test, a decision was made to deepen from under the 7-in. casing. Attempts to increase the mud weight above 12.5 lb

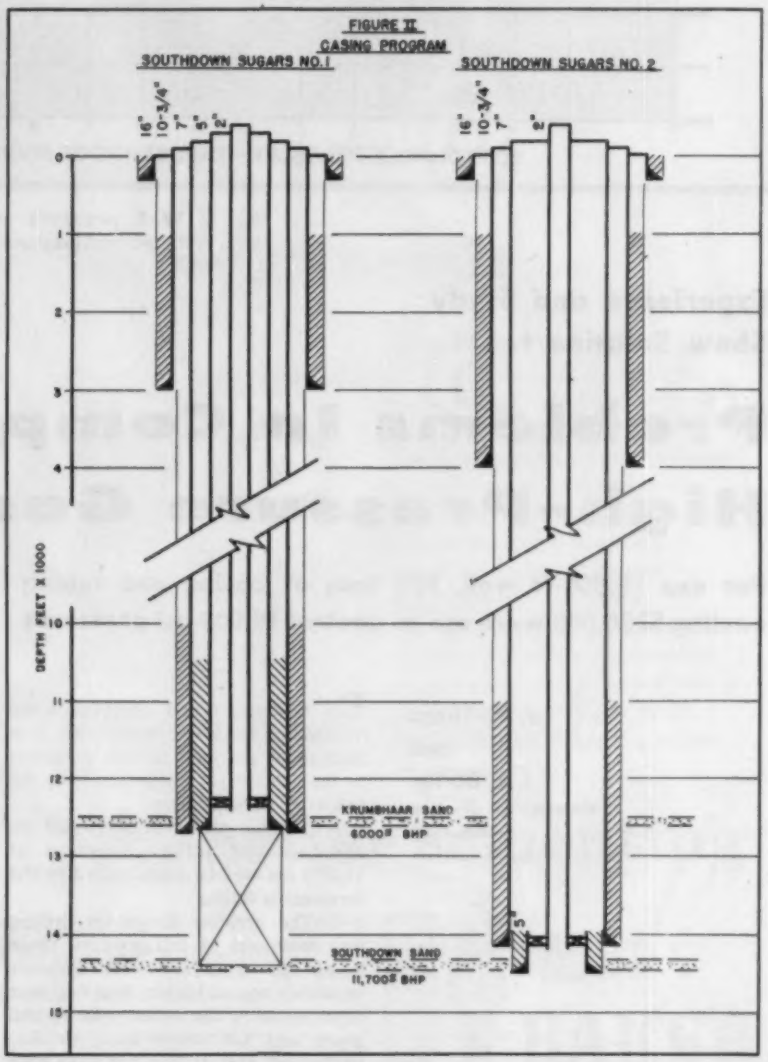


FIG. 2. **Completion program** for discovery well (left) and second well based on experiences gained from No. 1. Well at left blew out and burned up rig. Shut-in pressure of Well No. 2 was 9555 psi.

per gal resulted in lost circulation. When a depth of 14,356 ft was reached, the well kicked and before it could be brought under control a flange connection failed, the well blew completely out of control, caught on fire and destroyed the rig. The well was brought under control after becoming partially bridged with shale and was successfully completed in the 12,500 ft Krumbhaar Sand.

The second well drilled in this field and the first to be completed in the Southdown Sand, the Southdown Sugars No. 2, was drilled and completed through perforations 14,436-14,466 ft without incident by use of the following program, also shown in Fig 2:

Size (in.)	Wt/ft	Grade	Connection	Setting depth
16	42.8	Armco	Slip weld	272
10¾	45.5	J-55	API, 8-R	4,008
7	29 & 32	S-95	API, 8-R	14,114
5	18	N-80	Extreme line	13,961 to 14,486 (liner)
2⅜	4.7	9% Nickel	Hydril C-S	14,173

5" Drillable Packer at 14,167'
Completion mud
18 lb/gal. High P. H. Lime Base Mud 0-9300'
18 lb/gal. Bentone Mud 9300' to 14,167'

On test, this well flowed 13,897,000 cu ft of gas per day with a condensate yield of 21.5 bbls per million, with a flowing pressure of 7706 psi and a shut-in pressure of 9555 psi. As mentioned before, this well produced over two billion cubic feet of gas before it was shut-in and loaded with mud pending a thorough investigation of the adequacy of the tubular program.

Well Completion Problems

Tubular goods. The failure of casing in a completed well with pressures of the magnitude of those experienced by Tidewater at Houma is not only undesirable, it is practically intolerable. Tidewater's experience on their Elfert No. 1 at Houma is an example of the hopeless situation that can arise. The casing program for this well was approximately the same as that for the successfully completed Southdown Sugars No. 2 except that only the top 2500 ft of the tubing was 9 per cent nickel with C-S connections. Balance of the tubing string was N-80 with Spang Seal joints. The tubing was tested on the rack and the connections were tested when the tubing was run to 11,000 psi.

After producing for approximately 30 days at a rate of 11,000,000 cu ft per day and a flowing pressure of 8200 psi, the flowing pressure unexplainably dropped to 6100 psi for the same rate. The well was shut-in one hour and built up to 6707 psi, compared to a normal one hour shut-in pressure of 9200 psi. The casing pressure was checked and 4600 psi was observed. Efforts to bleed the casing pressure off were unsuccessful. Eighteen and one-half pounds per gallon mud was mixed and started into the tubing in an attempt to kill the well.

The surface pumping pressure built up to 8400 psi on the tubing and suddenly dropped to 0. At the same time, the casing pressure increased to 8300 psi and suddenly dropped to 2400 psi. When the well was shut-in, the pressures at the surface were practically equalized at 2400 psi on the 10¾-in. and 7-in. casing, and on the tubing. Several hundred barrels of mud were pumped into the various annuli and the tubing with no success in killing the well.

Subsequent operations conducted under pressure revealed that the 9 per cent nickel tubing had split at 2154 ft and the 7-in. casing was parted at 8970 ft. The casing was damaged so badly that it was impossible to get below 8970 ft with any tool without going outside the casing. The constant, relatively low surface pressure indicated the Southdown Sand was flowing out the parted casing. This appeared to be an impossible situation to deal with since the formation opposite the hole in the casing would not support mud with a weight of more than 12.5 lbs per gal, while the Southdown Sand required 18 lbs per gal mud for control. After several weeks of fruitless effort, Mother Nature came to Tidewater's rescue with a shale bridge, which assisted in killing the well.

In addition to being a prime example of an impossible situation that can result from a casing failure, experience on the Elfert No. 1 emphasized one other point. Heavy mud behind the primary pressure containing string, which in this case was the 2⅜-in. tubing, gives little more protection against tubing leaks in the upper part of the string. Furthermore, in this particular case, heavy mud probably contributed to the fatal casing failure. The casing withstood the wellhead pressure of 8300 psi; however, when the pressure differential caused by the difference in the hydrostatic head of the 18 lbs per gal mud inside the 7-in. and the 12 lbs per gal mud outside the 7-in., was added to this wellhead pressure, it ruptured the casing at approximately the top of the cement.

Another important point proved by the tubing failure in the Elfert No. 1 was the inadequacy of pressure testing alone as a means of inspecting tubular goods.

Higher yield strengths. The operators have recognized that to safely complete and produce a well, the long string of casing must be capable of containing the wellhead pressure. Casing to meet this requirement with a reasonable safety factor in the wells with 10,000 psi or more surface pressure is not available in API grades and weights. Such casing must then come from heavier weights or from steel with a higher minimum yield than that of N-80. The greater wall thickness would present clearance problems with respect to other strings of pipe and standard size subsurface tools and equipment. Also, the connection problem becomes more acute with greater wall thickness. These objections to the greater wall thickness makes it desirable, in Tidewater's opinion, to consider higher yield strength materials. Figs. 3 and 4 show the relationship of wall thickness to minimum yield

The Authors

J. E. Bailey

J. M. Tharp, Jr.

J. E. Bailey is division petroleum engineer, southern division, for Tidewater Oil Company. A Louisianan by birth, Bailey studied engineering at Tulane and Rice. He joined The Texas Company at Port Neches, Texas, in 1917. Following service in World War I, he joined the Pure Oil Company. In 1934 and 1935, during the East Texas boom, he was a petroleum engineer with the Texas Railroad Commission in Kilgore and for the following two years in Austin as chief petroleum engineer for the Oil & Gas Division. He joined Tidewater in 1937 as a district engineer, and was later advanced to assistant superintendent of production.

J. M. Tharp, Jr., is district superintendent, Offshore district for Tidewater Oil Company in Houston, Texas. He was graduated from the University of Oklahoma with a BS degree in petroleum engineering in 1945. He joined Tidewater in 1946 in Midland, Texas, and has served in various capacities in Midland, Hobbs, New Mexico, and Tulsa, Oklahoma before being transferred to Houston in 1951.

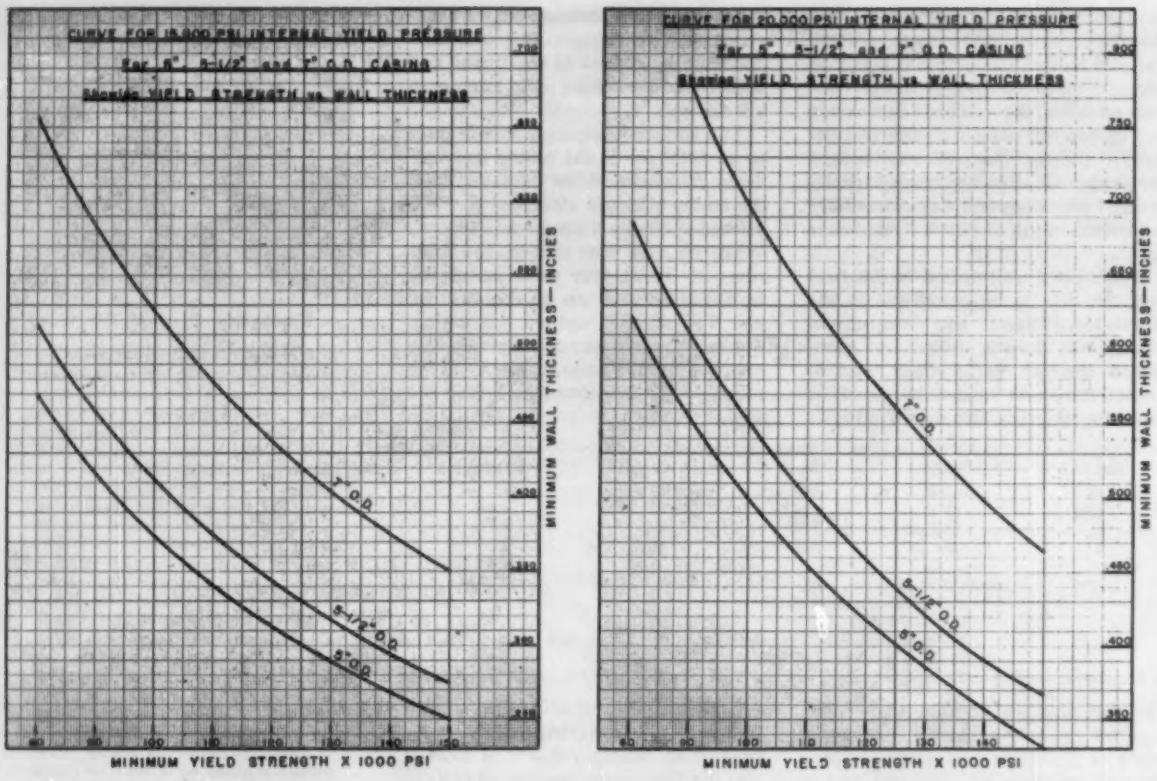

CURVE FOR 15,000 PSI INTERNAL YIELD PRESSURE
For 5", 5-1/2" and 7" O.D. CASING
Showing YIELD STRENGTH vs WALL THICKNESS
MINIMUM WALL THICKNESS — INCHES
7" O.D.
5-1/2" O.D.
5" O.D.
MINIMUM YIELD STRENGTH X 1000 PSI
CURVE FOR 20,000 PSI INTERNAL YIELD PRESSURE
For 5", 5-1/2" and 7" O.D. CASING
Showing YIELD STRENGTH vs WALL THICKNESS
MINIMUM WALL THICKNESS — INCHES
7" O.D.
5-1/2" O.D.
5" O.D.
MINIMUM YIELD STRENGTH X 1000 PSI

FIG. 3 and 4. **Relationship of wall thickness** to minimum yield strength of steel for 15,000 psi (curve at left) and 20,000 psi (right) minimum yield internal pressures for 5-in., 5½-in., and 7-in. outside diameter casing.

strength of the steel for 15,000 psi and 20,000 psi minimum yield internal pressures for 5-in, 5½-in. and 7-in. OD casing.

The higher yield strengths can be obtained by heat treating either carbon or alloy steels. High yield strength tubes made from alloy steels have been available in sizes up through the nominal oil well tubing sizes. As a result, alloy tubing has been used in wells where high yield strengths were required. Numerous failures of the alloy tubing at well below the rated bursting pressures have caused concern by the operators.

Tests and investigations have repeatedly shown that strength of steel at the failures was above specifications. It is almost invariably found that the failures are associated with some crack, surface cut, notch, or other imperfection in the tube. Many of these defects originated in making the tubes or upsets. Others developed during heat treating. Some have been caused by tongs or in running the tubing.

Precautions. It has become evident that high strength alone does not assure safe tubular goods for wells. It is of the utmost importance that the steel also have the ability to withstand the stress concentrations that develop at any thread, cut, notch, or crack that might be present. This is more difficult to accomplish with high strength steels, which by their very nature tend to be brittle. It is much more important, therefore, in using the high yield strength tubular goods, that every effort be made to obtain pipe free from defects.

In field operations, tongs, slips, and other tools will cut or notch the pipe. A notch acts as a stress riser when the material is highly stressed, which may cause the notch to suddenly grow and the material to rupture in a brittle fashion. The lower strength, more ductile materials will yield, thus redistributing the stress pattern. Because of its susceptibility to notch failures, good notch toughness becomes a most important quality of the higher tensile strength steels.

Casing made of steel with a minimum yield of 110,000 psi (compared to 80,000 psi for N-80) has been available for some time in limited sizes and weights. This higher strength material was obtained by the additional heat treatment of carbon steel. Collar stock for certain sizes of this casing and a limited amount of casing of nominal sizes have been manufactured from steel with minimum yields of 140,000 psi to 150,000 psi. Fig. 5 is a graph showing the relationship of minimum yield strength of the steel and minimum yield internal pressure for various sizes of casing with the greatest wal lthicknesses now available.

Tidewater has conducted a number of tests on material with yield strengths up to 150,000 psi. Generally, the higher strength materials are satisfactory as far as performance of present equipment such as hanger slips, packers, and tongs is concerned. The material was also perforated with jets and bullets, and satisfactory penetration was obtained without cracking of the material.

Connections. Once the casing for a high pressure well has been selected, the problem of connections immediately arises. The connection should possess 100 per cent efficiency for both tensile strength and leak resistance. The API connection fails to meet either qualification. Several other connections available up to a few months ago were promising in both respects, but were not considered by Tidewater because they required upsetting the casing. This was deemed undesirable because of the problems of heat treating the upset joints and obtaining uniform strength with no flaws. Several manufacturers are offering, or

plan to offer, a pressure-energized seal in connection with the high tensile strength connection. This principle appears to have very good possibilities for a strong and leak resistant connection.

The Hydril Triple Seal connection was one of the available integral type connections offering promise from both the strength and leak resistant standpoints. In order to avoid the necessity of expanding the high yield strength casing, Hydril designed a connection incorporating the same strength and leak resistant qualities, but utilizing collars for the box part of the connection. For this connection, the ends of the pipe are swaged slightly by cold working to provide heavier wall thickness at the location of the seal. Five joints of 4½-in. pipe and five joints of 7-in. pipe were manufactured for Tidewater to test. These joints were subjected to nitrogen gas pressures equal to 80 per cent of the minimum yield of the steel and held without any leaks through 100 cycles of temperature change from 80 F. to 180 F.

The next well to be drilled by Tidewater in which surface pressures in the 10,000 psi range are expected is a partnership venture with Gulf Oil Corporation, The Atlantic Refining Company, Amerada Petroleum Corporation, and others, in the Church Point area of Acadia Parish, Louisiana. After a thorough review of the tubular goods situation, these companies decided to utilize the 110,000 psi yield strength casing and the new Hydril RB connection for the pressure containing casing strings.

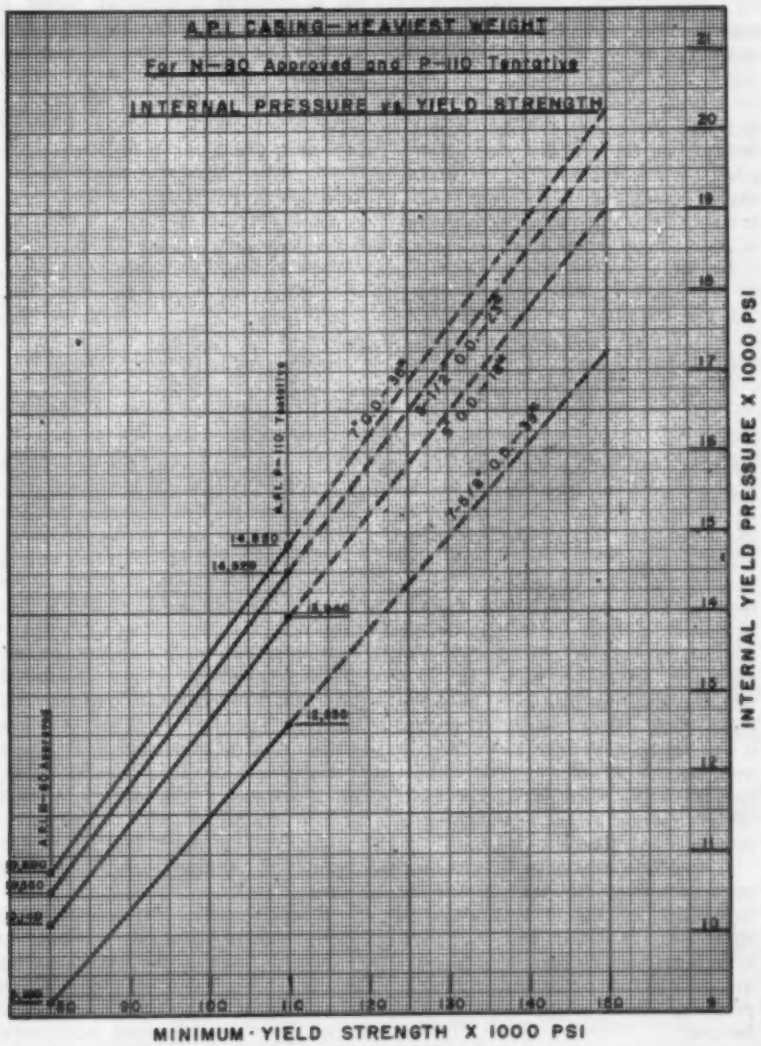

A.P.I. CASING—HEAVIEST WEIGHT
For N—80 Approved and P—110 Tentative
INTERNAL PRESSURE vs. YIELD STRENGTH
INTERNAL YIELD PRESSURE X 1000 PSI
MINIMUM · YIELD STRENGTH X 1000 PSI

FIG. 5. **Relationship of minimum yield strength** of steel and minimum yield internal pressure for various sizes of casing with the greatest wall thickness now available.

Inspection. Once it has been determined that casing and connections that will satisfy the requirements of a high pressure well are available, the next problem is that of an adequate inspection procedure. One small undetected defect in material can nullify all of the cautious selection of equipment. There are almost six miles of casing capable of holding wellhead pressure in the casing design of the Tidewater Church Point well being planned. It would be an exception, rather than the rule, if this much equipment could be manufactured by the mass production methods necessary to make it economically feasible, without some imperfections. Many of these imperfections can be detected by gages, visual inspection and pressure testing. Minute flaws in the steel that reach the surface of the pipe, but cannot be seen, can be detected with magnetic particle inspection. Large flaws within the steel also can be detected with magnetic particle inspection in some cases. Defects most elusive to ordinary inspection methods are variation in hardness and small defects in the steel that do not reach the surface of the pipe.

An increase in hardness is an indication of an increase in brittleness, which in turn is very susceptible to shock load failures even though the minimum yield of the steel is higher than required.

Corrosion. In the completion of a high pressure gas well, consideration must be given to the corrosion problems that may arise. Wall reduction of tubular goods is more critical in this type of well, since the designed safety factors can be greatly reduced by pit type or ring worm corrosion.

Failures due to corrosion can occur from both external and internal attack. The external attack is mostly electrolytic in nature and is generally limited to casing, flow lines, or surface equipment. Internal corrosion is mostly chemical in nature and may occur in the tubing, wellhead equipment, flow lines or surface equipment.

Casing corrosion can occur due to current flowing into the well from the surface and leaving the casing in the path of least resistance. Corrosion will occur at the point, or points, where current is discharged to the ground. If this current discharge is spread out fairly even over much of the string, a failure is not likely to occur during the life of the well, but if the current is leaving in a small section of the string, a failure could occur in a short time. One ampere of current destroys about 20 lbs of metal in one year. To reduce the chance of this type of failure, an insulated fitting will prevent current flow from the surface into the well. With this preventive measure, electro-

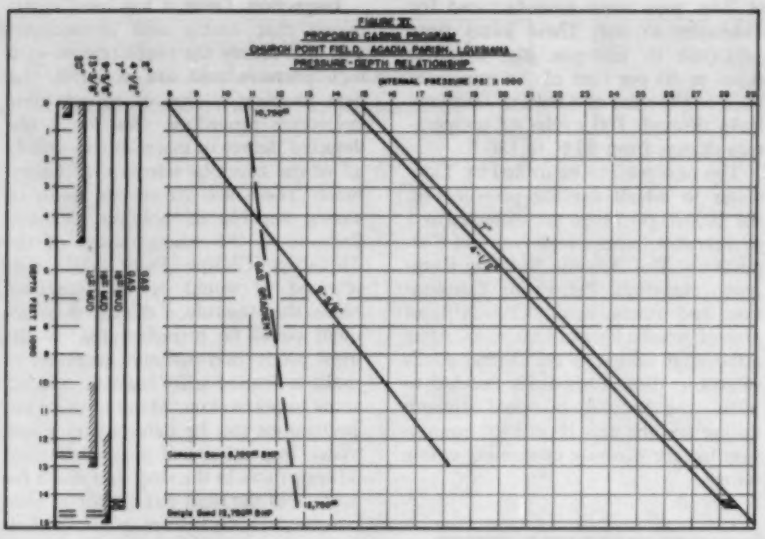


FIG. 6. **Proposed casing program** for South Louisiana well, showing pressure-depth relationship. Steel represented here weighs about 970 tons and costs $320,000.

lytic casing corrosion would be limited to subsurface circuits, which may or may not extensively damage the string.

It has been shown that cathodic protection will alleviate casing corrosion and, in the next several years it may be desirable, or necessary, to cathodically protect the casing strings of all wells with a long life expectancy.

If a packer is set and the annulus is loaded with mud, corrosion to the internal surfaces of the casing is minimized. If inhibitors can be injected into the annular space, the external tubing surfaces and the internal casing surfaces should suffer little or no damage from corrosion.

Internal corrosion in extremely high pressure gas wells is dependent upon the produced fluids, which is generally true for all gas wells. The NGAA studies of this problem indicated carbon dioxide to be the major corrodent. It is generally assumed that the partial pressure of carbon dioxide indicates the relative severity of the attack. This means that at high pressures, smaller amounts of carbon dioxide can produce high partial pressures and cause severe corrosion. In Gulf Coast reservoirs, 1 mol per cent of CO_2 in the gas is quite common and at 1000 psi, a partial pressure of 10 psi should do moderate damage. When 1 mol per cent of CO_2 exists at 9000 psi, the resulting partial pressure is 90 psi, which is indicative of severe corrosion.

Organic corrosion inhibitors in common use can be injected into a high pressure well to afford some reduction of iron content of the produced water. Treatment of Tidewater's high pressure wells has been with stick inhibitor only. Such treatment was not as satisfactory as desired, and operational problems occurred due to the necessity of closing the well to treat it. It is not known if the present commercial inhibitors will perform as well in the high pressure wells with the higher temperatures as they do in the usual gas wells. However, the injection of inhibitor down the annulus and up through the flow string would be the most desirable method of treating.

Special alloy tubing as a corrosion control measure is not usually economically attractive. Nine per cent nickel tubing was run in Tidewater's initial high pressure completion, but it was necessary to treat the well due to wellhead and flow line corrosion. Present Tidewater plans for future wells favor inhibitor injection and a minimum of alloy materials.

Completion summary. After a thorough review of their experience, the experience of others and available equipment, Tidewater and their partners proceeded to determine the requirements for an optimum tubular program. These requirements are as follows:

1. There should be primary pressure containing string within a standby or secondary pressure containing string, with each capable of containing the expected shut-in surface pressure or any conceivable combination of surface pressure and hydrostatic pressure due to differential mud gradients.

2. The primary pressure containing string should be removable to facilitate the replacement of any joints or connections that might fail, rather than depend upon squeeze cementing for leak repairs.

3. The tubing or flow string should extend to or below producing perforations, should be open at the bottom, and should have full communication with the annulus between it and the next larger string of pipe. This arrangement will facilitate corrosion mitigation by injection of inhibitor into the annulus and will permit killing the well by circulation rather than pumping into the formation.

4. The tubing or flow string should be as large as possible to permit a minimum velocity of produced substances and to permit the highest possible pumping rate without excessive pressure during killing operations.

With these factors in mind, the following casing program for the Church Point well, which is shown diagrammatically in Fig. 6, was selected:

This program totals 970 tons of pipe which will cost approximately $320,000. The Buttress thread connections on the 13⅜-in. are to provide additional compressive strength for supporting the weight of the other strings of casing. The 4½-in. pipe will be set on a Baker Special "DA" 4½ x 7-in Packer.

Size (in.)	Wt/ft	Grade	Connection	Setting depth (ft)	Remarks
20	94	H-40	Slip joint	500	Cemented
13⅜	72	N-80	Buttress	0-1000	—
13⅜	68	J-55	API	1000-3800	—
13⅜	72	N-80	API	3800-5000	Cemented
9⅝	53.5	N-80	Speedtite	13,000	Cemented
7	38	Deep well	Hydril RB	15,000	Cemented
4½	15.1	Deep well	Hydril RB	15,000	Set on packer
2⅞	4.7	N-80	Hydril CS	15,000	Hanging free

At least two other companies, Continental Oil Company and Union Oil and Gas Company of Louisiana, are making extensive use of the principle of hanging the flow tubing free as is being planned by Tidewater. However, they are using 2⅞-in. rather than 4½-in on a packer as the primary pressure containing string, and 1¼-in tubing to only 9000 or 10,000 ft for flow tubing.

It will be noted that no attempt is being made to circulate the cement on either the 7-in or the 9⅝-in. casing strings. It was Tidewater's opinion that the filling of the annulus with cement does not give assured additional strength to the 7-in. casing. This is because the differential movement of the two strings of casing, due to temperature changes as the well is flowed and

shut-in, could tend to break the cement seal.

Wellhead Equipment

When it became apparent that there would soon be a demand for wellhead equipment with a working pressure of 15,000 psi or greater, manufacturers started designing it. C. H. Taylor reported in a paper at the 1955 spring meeting of the Southwestern district of the API, that for 15,000 psi working pressure a single API flange having a bore of 6⅛ in. would have an outside diameter of 42 in., a thickness of 15-9/16 in., and would weigh 5940 pounds. Mating flanges would require 20 bolts having a diameter of 2¾ in. It is obvious that such a joint would not have field application, for practical and economical reasons.

The pressure-energized seal principle such as is incorporated in Gray Oil Tool's Graloc, Oil Center Tool's Flex-Float Ring and Cameron's Modified API Ring appears to be one answer at present for end connections for christmas tree component parts for working pressures in the 15,000 psi range.

This type connection has been subjected to extensive shop testing, but only limited field testing under severe conditions. Extensive field testing under severe conditions will be required for industry wide acceptance of the present designs of this type connection.

Principal features of a connection utilizing this type of seal are as follows:

1. The effective area on which the wellhead pressure is acting and tending to part the connection is reduced. This reduces and parting force and permits the use of flanges with a smaller OD and thickness, smaller bolts and fewer bolts. One manufacturer has developed a two bolt clamp to use with their seal rather than the flange.

2. It is not absolutely necessary to stress the bolts of a flange to above the maximum expected stress under operating conditions to prevent bolt stretch. In the case of an API ring gasket seal, the slightest bolt stretch will result in a leak. In the case of the pressure-energized seals, the seal is not affected by a reasonable amount of movement of one side of the connection relative to the other side.

These features of the pressure-energized seal connections result in the following advantages over the API ring gasket connections for high pressure wells: 1. Lighter weight christmas tree; 2. saving of installation time; and 3. a more efficient seal.

Safety Controls

Conventional subsurface safety controls such as storm chokes and bottomhole regulators have been used in high pressure wells. However, these are effective only when tubing through which the well is produced is set on a packer. No safety controls that can be serviced with a wire line are available for wells completed with the producing tubing hanging free. This equipment has certain disadvantages even when it is possible to use it. Some of these disadvantages which must be weighed against the advantages when making a decision on the use of safety controls are: 1. Difficulty of wire line work at high surface pressure; 2. Possibility of accelerated corrosion or erosion damage to the controls or the tubing at high rates of flow; and 3. The undesirability of this equipment in the tubing string during killing operations.

Downstream Production Problems

In designing surface facilities for handling the expected 9000 psi wellhead flowing pressure of the Southdown Sand at Houma, there was considerable conjecture as to the hydrate problem involved in expanding the gas to line pressure. Serious consideration was given to the installation of a series of subsurface regulators to effect an expansion to 4000 or 5000 psi before reaching the surface. A check of an enthalpy-entropy diagram indicated the possibility that the temperature of the gas would increase rather than decrease while expanding from 9000 psi to 5000 psi and then decrease as expected upon expansion to line pressure. Upon completion of the first Southdown Sand producer, subsurface regulators were not installed and the 9000 psi flowing pressure was reduced through a surface regulator to 4000 psi. When production commenced, the theory of temperature increase upon expansion of the gas in the high pressure range was confirmed by temperature observations upstream and downstream of the regulator. T. Ed Griffith and C. O. Miller presented a paper at the 1954 annual convention of the Natural Gasoline Association of America in which the thermodynamics of this phenomenon are discussed in more detail.

There are surface high-low shut-off safety controls available with sufficient working pressure rating to withstand surface pressure encountered to date. One possible problem, the severity of which has not been determined, is the rather quick action upon closing. There is substantial mass moving at a rather high velocity when a well with 9000 psi flowing pressure is producing at a rate of 10 or 15 million cubic feet per day. There is, in all probability, some shock loading involved when this flow is abruptly halted. Tidewater has been unable to determine the extent of these shock loads. A surface safety valve that closes with a dampened action would reduce the shock load. Such a valve is being considered by manufacturers but, to date, has not been subjected to extensive field service.

Down-Hole Gas Expansion

The only producing problem encountered by Tidewater downstream from the wellhead believed to be peculiar to the production from high pressure gas reservoirs is caused by the physical properties of the condensate. This liquid has a stock tank gravity of 41.7 degree API and the heptanes plus fraction has a gravity of 38.5 degree API with a molecular weight of 217. Considerable difficulty was encountered in the operation of conventional two-stage separation due to the high pressure separator waxing up and causing excess condensate carry-over with the residue gas stream. A parallel high pressure separator was installed to facilitate regular steaming without interruption of producing operations. The liquid begins to thicken at 99 F and has a pour point of 60 F.

As pointed out by Griffith and Miller, it now appears that gas produced from reservoirs having higher pressures probably will have more aggravated wax problems. The existence of heavier components in the vapor phase in the reservoir is becoming more generally accepted. Whereas past beliefs indicated that off colored liquids and dark oils existed in the reservoir in the liquid phase, it now appears that a large portion of these possibly could exist in the gas phase. Additional production history, material balances, and laboratory tests will be required to verify this.

Acknowledgment

This paper is a joint effort of several persons connected with the problem in the Tidewater organization. We wish to thank the supervisory personnel in the operating department for their constructive criticism and the management for their permission to present the paper.

References

Taylor, C. H. — End Connections for Christmas Tree Components in the 15,000 psi Working Pressure Class, presented at the spring meeting of the Southwestern district, division of production of the API, New Orleans, Louisiana, March, 1955.

Griffith, T. Ed, and Miller, C. O. — Problems Associated with High Pressure Gas Production, presented at the Natural Gasoline Association of America's annual convention, Dallas, Texas, April, 1954.

Editor's Acknowledgment

Original paper entitled "Problems in High Pressure Gas Production" was presented at the Ninth Oil Recovery Conference sponsored by the Texas Petroleum Research Committee at A and M College at College Station, Texas, May 9-10, 1956. ★ ★ ★

POWER TRANSMISSION

Allan B. Fredhold, Jr.*

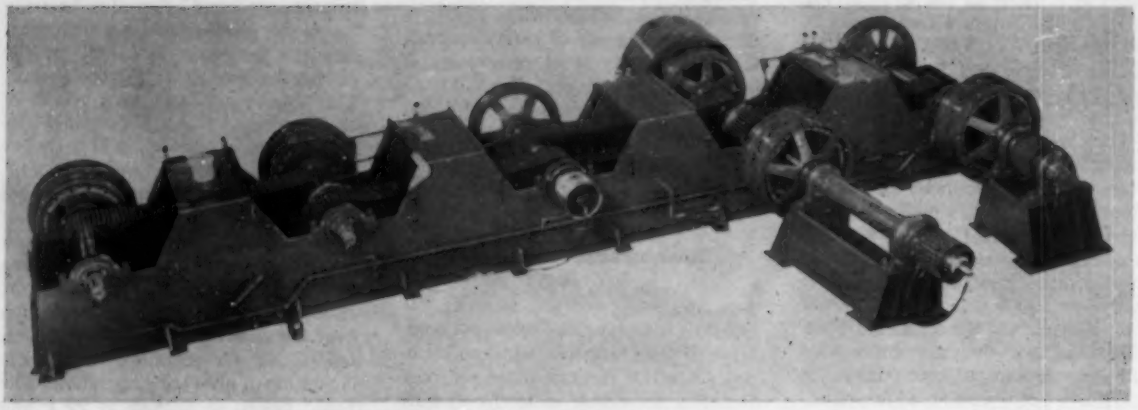


FIG. 1. Pumps compounding transmission showing lift-out with covers removed. American Tidelands, Inc.

A drilling rig requires power for hoisting, rotating, pumping and service auxiliaries. This power is supplied by the prime mover, such as an internal combustion engine, a steam engine, or an electric motor. However, the power of the prime mover must be provided with the means by which it can be transported or can flow to its point of final use. It is also necessary in the majority of cases to adapt or change the original form of the power in some degree.

Means by which the power is transmitted to its point of use, adapted or converted for application, and controlled is called Power Transmission. In a drilling rig the transmission of power is usually accomplished by mechanical means such as chains, belts, or gears. Conversion or adaptation of power on the other hand utilizes in addition to these mechanical methods both hydraulic and electrical devices in the form of special couplings and converters. The control of the power during such transmission or adaptation is provided by, in addition to the foregoing, such equipment as air or mechanical clutches.

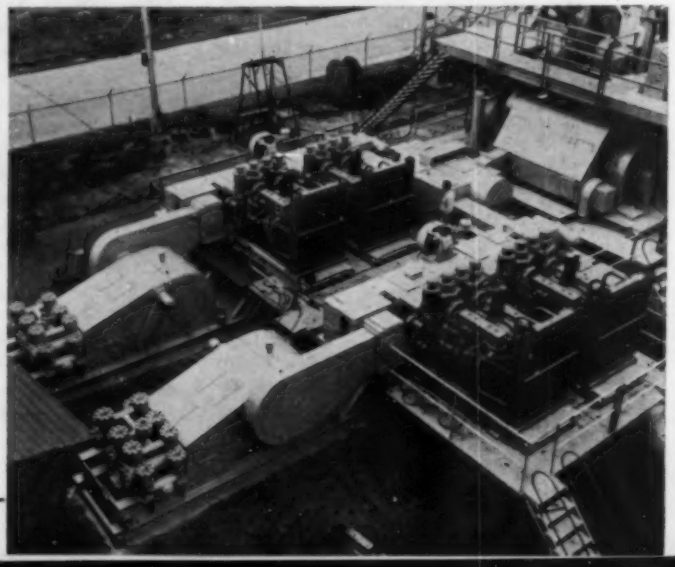
The design of a power transmission system is a difficult compromise between a number of conflicting requirements. On one hand heavy duty design is best served by high rigidity and great weight, while on the other hand quick and easy portability are the backbone of present drilling operations. Cost, field serviceability, and design features plus simplicity serve to further complicate the production of any "perfect" design.

Uses

Compounding Transmission. In medium and large sized rigs it is necessary to combine the power of two or more prime movers for pumping or hoisting operations. This is accomplished by a compounding transmission. Although formerly other means such as V-belts — were used, all present day compounding transmissions use chain to combine the power of the engines before transmitting it to its point of application. In addition to combining power, most modern compounding transmissions incorporate various multi-clutching means so that the power can be combined or directed in a number of combinations to satisfy the multitude of power division requirements for all drilling phases.

Within the last few years the advent and acceptance of jet bitting techniques has changed the power requirements of oil well drilling so that now pumping power requirements often over-shadow hoisting power requirements. Further, pumping requirements are semi-continuous in nature as opposed to the intermittent nature of hoisting power. A large multi-engine chain compounding pump transmission with the inspection covers removed is shown in Fig. 1. Two single-lever controls on the top of the case are used to mechanically actuate splined clutches so that a variety of engine power flow selections is provided. This allows the necessary amount of power (number of engines) to be directed to the output shafts. Actual provision

FIG. 2. Compound transmission on location. Ideco



*Consultant Engineer, Burbank, California.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

FIG. 3. Poly-V drive operating 900-hp mud pump on West Texas rig. *Rexbestos-Manhattan*

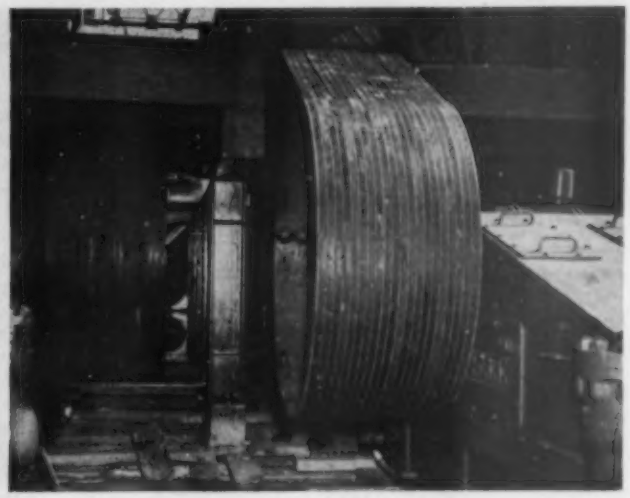


FIG. 4. V-belts on two mud-pump drives operating from three 600-hp diesels. *U. S. Rubber*

for pump drive is made in this transmission by the one long and one short pump pedestals at the rear of the compound. Large slush pumps will be chain driven from these pedestals by locating the pumps below the compounding transmission in a stair step arrangement.

Power Flow. Power is usually transmitted to the slush pumps by V-belts from the integrated rig compounding transmission; or in the case of an individual pump package from the pump engines or special compounding case.

Where power requirements are particularly heavy, or where relative location of driver and driven sprockets can be fixed, chain drives as noted in Fig. 1 are sometimes used. Two examples, using Poly-V and V-belts respectively between mud pumps and engine compound, are shown in Fig. 3 and 4.

Power flows from the compounding transmission to the drawworks where it is used to hoist and rotate the drilling string. It is also required for such important auxiliaries as catheads, integrated sandreels, etc.

On most rigs an additional selective speed change is provided between the compound and the drum. This transmission provides a number of optional forward speeds plus a reverse so that where these speeds, such as three forward and one reverse, are combined with two speeds in the drawworks six hoisting speeds, three rotary speeds, and two reverse drawworks speeds, are available. The forward speeds are usually chain drives with the reverse provided in the selective transmission by gears. However, in some cases a chain reverse and/or geared forward system is utilized. Due to the many different rig designs the number of speeds used is, however, far from standardized. A modern selective transmission used on a 1200 to 2000-hp drilling rig is shown in Fig. 5. The compound transmission is also the usual direct source of power for such auxiliaries as washdown pumps, generator and compressor packages, oil pumps, etc. These items of equipment are normally driven by chain or V-belt drives although other means have been used. An air compressor driven off the compound of a 900-hp drilling rig is shown in Fig. 6.

A schematic plan view of all the major power transmission components used in a 900-hp integrated drilling rig for pumping, hoisting and rotating is shown in Fig. 7. This speed diagram shows the chain, sprockets, clutches, gears, sheaves, etc. normally used in a medium size modern drilling rig. This schematic provides a good representation of power transmission within the modern drilling rig.

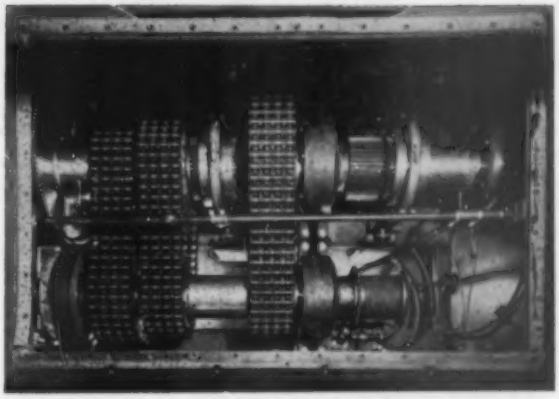


FIG. 5. Gear and chain selective transmission. *Unit Rig*

FIG. 6. Transmission-driven air compressor. *Bethlehem Supply*

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

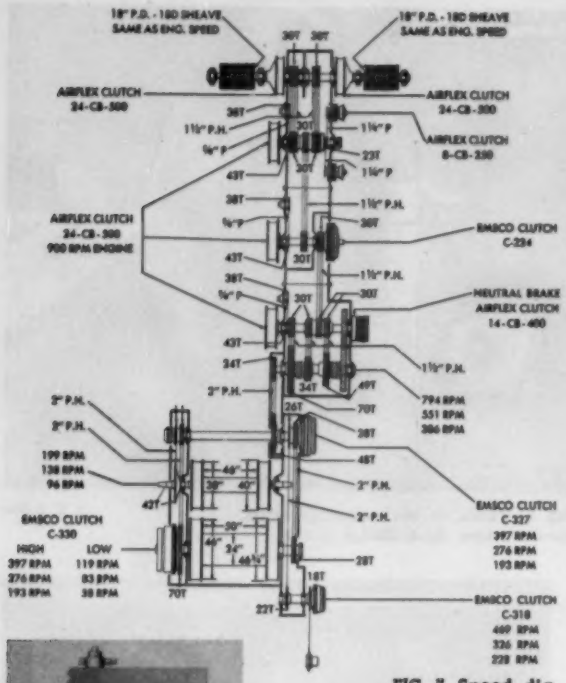


FIG. 7. Speed diagram of a 900-hp drilling rig. *Emsco*

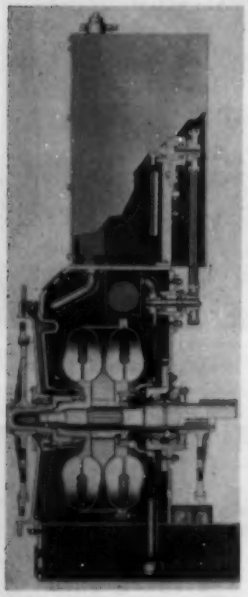


FIG. 8. Cutaway view of fluid coupling. *Twin Disc*

Special Drives

As previously mentioned, the control, and conversion or adaptation of power, often utilizes special drive means in the form of hydraulic or electrical equipment. This equipment provides a number of advantages, but only at the expense of some other factors. In designing or adapting components for a balanced drilling rig it is necessary to make the best compromise possible between the advantages and drawbacks of all the equipment so that the specific design criteria can best be satisfied.

Hydraulic Couplings—Fluid Drive. The simple hydraulic coupling as represented by the fluid drive is used as a shock reducing means of power transmission. By putting a fluid cushion between the driver and driven equipment it serves to isolate each from any detrimental power shocks or vibrations that might otherwise be transmitted between the two. The fluid drive can be obtained in either a constant speed or an adjustable speed design. With a full compliment of oil in the fluid drive, and when the output shaft is operating at top speed, the device has a high efficiency. In all cases, for either the constant speed or the adjustable speed fluid drive the efficiency is, for all practical purposes, proportional to the percent slip. The principle of the coupling is illustrated by the special turbine-type fans shown in Fig. 9. In this illustration one fan serves to transmit the input power from its blades or impeller through the air acting as a fluid to the output shaft of the second fan or runner. Any shocks, vibrations, etc., are thus isolated to driver or driven system as there is no mechanical connection between the impeller and runner.

The operational characteristics of the fluid coupling are shown in graph form in Fig. 10. There are a number of commercial adaptations of the basic fluid coupling principle. Two popular forms allow the fluid within the coupling, which acts as the power transmission means, to be removed either by degree or wholly. In this manner the partially filled coupling has its basic speed-torque characteristics reduced or controlled by the amount of fluid kept in the coupling. Either the adjustable filling coupling or the dumping coupling can be used as a power disconnecting or clutching means, in that the slip of the coupling can be varied from nearly zero when full to 100 per cent when completely empty. Applications of medium or large adjustable speed-type couplings are shown in Fig. 11 being installed on the compounding transmission of a deep drilling rig.

Hydraulic Torque Converter. The hydraulic torque converter is a basic modification of the simple hydraulic drive or fluid coupling, as shown in Fig. 12. The converter provides the same shock reducing action as the coupling but

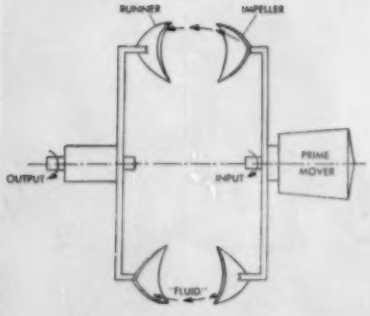


FIG. 9. Sketch of fluid coupling drive principle.

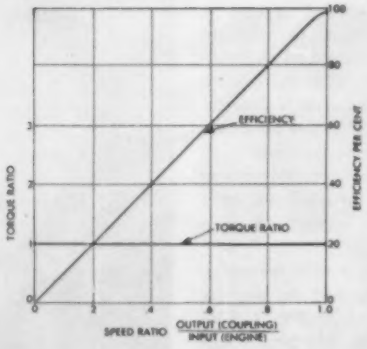
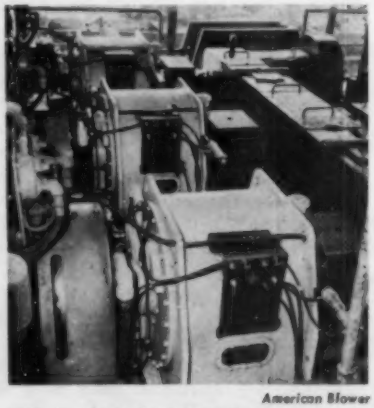


FIG.10. Fluid coupling characteristics.



American Blower

FIG. 11 Gyrol fluid drive installation on a rig compound.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

FIG. 12. Compound showing torque converters. *Wilson Manufacturing*

it is so designed that the input torque of the engine or motor is converted and multiplied, at the sacrifice of speed, when made available at the output shaft. This is accomplished at greatly reduced efficiency compared to the very high efficiency available within the coupling. A cutaway of the torque converter is shown in Fig. 13.

It is possible to approximate the operational principles of the converter by again using the illustration of the two turbine type fans. In the converter a stationary reaction member is added that takes the fluid that leaves the runner and directs it back onto the impeller again. In this manner the "rebound" energy of the fluid serves to pre-charge the fluid into the impeller. Due to this added reaction conditions are such that the efficiency is materially reduced in the converter. As a result of the pre-charging the torque or twisting moment of the runner is increased and as the runner speed becomes slower in relation to the impeller speed the fluid rebounds from the runner harder and is further pre-charged into the impeller so that maximum output torque is achieved at a multiplication of input torque when the runner is stalled. The turbine or bucket bladed fans with the reaction member added to illustrate the torque converter principle are shown in Fig. 14.

The operational characteristics of the torque converter are shown in graph form in Fig. 15. As shown in the figure, the converter's top operational speed ratio is in the neighborhood of 2 to 3 and in this area the efficiency reaches a maximum of approximately 80 per cent. Notice that any stopping, or enforced slowing, of the output shaft quickly increases the torque multiplication and attempts to overcome the resistance. In practical application terms the increased ability to turn the hoist, rotate the table, or operate the pumps without additional mechanical speed changes is somewhat paid for by decreased efficiency and resulting increased fuel costs. A balance of these two factors, plus the basic features of shock reduction and infinite intermediate torque multiplication must be obtained in the proper utilization of torque converters to drilling equipment.

Converter-Coupling Combination. It is possible to combine the operational characteristics of the converter and fluid coupling so that a portion of the advantages of each can be utilized. A graph of the operational characteristics of such a combination is shown in Fig. 16. This combination starts out like a standard hydraulic torque converter. However, as the output shaft comes up to speed and converter efficiency starts to fall off, the reaction member within the converter is "unlocked" by pressure on its rear side and free wheels or rotates so as to be nearly inoperative. As a result of this shift the converter approaches the operation of a coupling and continues in this manner until the speed of the runner is reduced enough in relation to the speed of the impeller to "re-lock" the reaction member and turn the coupling back into a converter.

Electromagnetic Drive —Electric Coupling. The electromagnetic drive or electric eddy current coupling has operational characteristics very similar to those of the hydraulic coupling. Control of the electric couplings, however, is obtained by controlling the input excitation current rather than by controlling the amount of fluid. By cutting off the external excitation current it is possible to de-clutch the coupling completely.

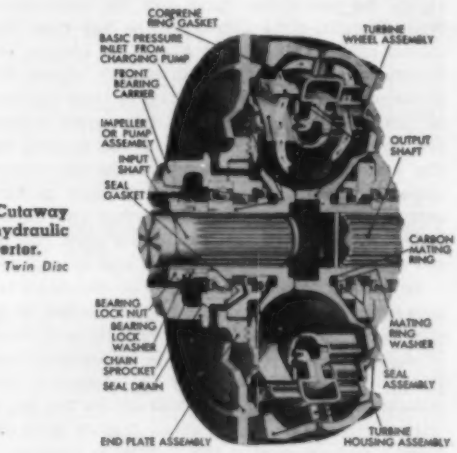


FIG. 13. Cutaway view of hydraulic torque converter. *Twin Disc*

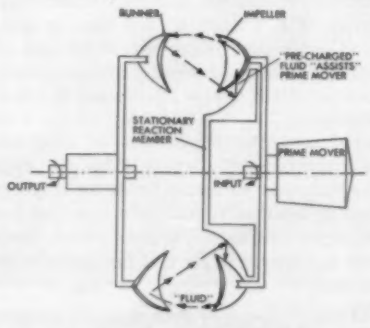


FIG.14. Schematic illustration of hydraulic torque converter principle.

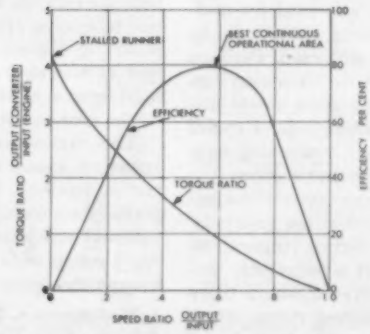


FIG. 15. Hydraulic torque converter characteristics.

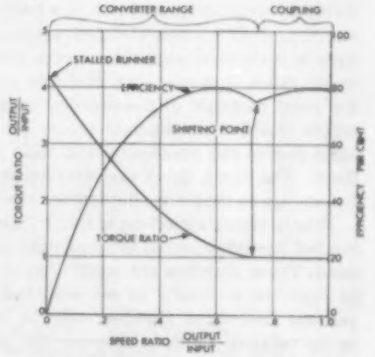
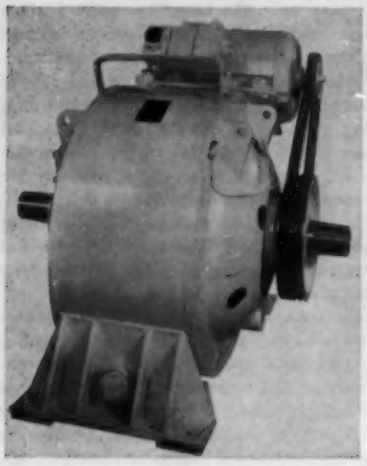


FIG. 16. Converter-coupling characteristics.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.



Baylor Company

FIG. 17. Electric eddy-type coupling.

Fawick Airflex

FIG. 18. Circumferential air tube clutch.

Wichita Clutch

FIG. 19. Multi plate disc air clutch.

It is possible with eddy current couplings to dissipate full engine power continuously. It is also possible to drive drawworks or pumps or rotary table at any desired speed with the engine or electric motor running at governed speed.

As a result of its similar operating characteristics the electric coupling is used for the same purposes as the hydraulic coupling. The main difference between the two has to do with the practical application features of control, cost, service and availability. A photo of electric couplings is shown in Fig. 17.

Maintenance. Due to the fairly complicated and specialized nature of all special drives very few generalized maintenance rules can be stated. It is, of course, best to follow the manufacturer's instructions as closely as possible. In hydraulic drives probably the most trouble is provided by (1) Dirty oil as a result of improper filling or filter maintenance; (2) Over-heating as a result of overloading or as a result of inefficient operation from running in the wrong gear; (3) Air in the system, sometimes resulting in reduced pressure and cavitation, as a result of improper filling and system bleeding.

Clutches

In addition to the clutching means provided by the special drives (such as hydraulic and electric couplings), mechanical and friction clutches, controlled by manual, air, and hydraulic action are also utilized on drilling rigs. In general, however, air has replaced hydraulic controlled clutches in the great majority of drilling rig applications.

Mechanical Clutches. The two general types of mechanical clutches used are jaw, and gear or splined clutches. The formerly popular jaw clutch has been largely replaced by air controlled friction clutches where it was used for multiple connections and disconnection during operations. In many cases, however, jaw clutches are still used. Perhaps the most common of present day uses is on the steam rigs where positive mechanical action can be more easily utilized due to the cushioning and wide speed range of steam itself. The same thing can also be noted concerning new steam rigs as they are adapted for electric motor drive.

Where clutching action is fairly "non-operational" for extended periods splined or gear type clutches are generally used. These clutches are controlled by shifting rings which in turn are manually or air actuated. It is extremely important that these clutches only be operated where there is no relative motion between the clutched parts, otherwise the teeth or splines will become easily burred and inoperable. A multiple position splined clutch used operationally is shown in Fig. 5. This clutch is controlled by a shifting ring which in turn is actuated by an air cylinder. This system is equipped with an inter-lock control so that the clutch can not be engaged until a neutral brake has stopped relative motion between the parts to be clutched.

Friction-Air Clutches. Practically all friction clutches on today's drilling rigs are of the direct air type in that the air is conducted directly into the clutch. Some mechanically or external air actuated friction clutches may still be used but adaptation to new drilling equipment is rare.

Of the direct air friction type there are two basic designs, the piston-disc type and the circumferential tube type. A multi-plate diaphragm or bag type disc clutch is shown in Fig. 19. In the disc type friction clutch air is introduced into the clutch so that by piston or bag action it compresses the surfaces of one or more flat moving plates or discs against the surfaces of an equal number of other flat stationary discs. Friction of the moving discs against the stationary discs thereby drags the stationary discs after the moving discs. As the pressure is increased both sets of discs become locked together and the clutch is engaged. When the air is exhausted from the clutch internal springs push the discs apart and disengage the clutch.

In the circumferential tube type clutch air is introduced into a bag or endless tube which is located along the outer circumference of a circle. An illustration of this type clutch is shown in Fig. 18. As air is introduced into the tube it expands, either externally or internally, until any circumferential clearance is taken up. As the bag is equipped with friction shoes these shoes grip or drag on their contacting surface so that the surface is brought into accompanying rotating motion with the bag section. Circumferential tube type clutches (Fig. 1 and 18) are used in compounding engines and controlling pump drives because of ease of assembly and a flexible alignment feature. A more rigid version of this type clutch is now being used in drawworks service applications.

The circumferential type clutch provides an easy and apparent means of a complete disconnect. The disc type clutch, however, has been used in the oil fields for a longer period than the drum or circumferential tube type and has received acceptance as an operational control clutch. Both types are in wide use but trends in air clutches seem to be toward the drum-type.

Maintenance. The maintenance of both disc and circumferential-tube type clutches must be determined by the specific manufacturer. For example, many disc type clutches

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

require special lubrication for their internal seals, while other disc types can not stand any lubrication, and practically no circumferential-tube clutches require it.

There are, however, one or two items common in regard to clutches that must be watched. First of these is for the operator to get as positive an engagement as quickly as possible. Do not allow the clutch to slip any more than necessary as even a little continuously repeated slipping will glaze the friction surfaces and ruin the efficiency of the clutch. Continual gross slippage on the other hand will not only glaze the surfaces but is apt to so over heat the clutch that the plates will become warped and tubes or bags will be ruined by the heat. Slippage can be caused by a number of factors, nearly all of which can be prevented by maintenance or proper supervision. Factors that cause slippage are: (1) improper operation of the controls; the clutch control should be engaged firmly and quickly and no overlapping of controls should be used. (2) Dirty, especially oily, clutch friction surfaces; these should be cleaned with solvent and kept guarded against entry of oil, dirt or grease. (3) Overloading of clutches; the right gear should be used whenever possible — "frogging" the pipe out of the slips with a high gear when going in the hole should be avoided. (4) Wet clutches, or low air pressure; clutches and air lines should be drained of condensate periodically and the minimum recommended air pressure should be maintained at all times.

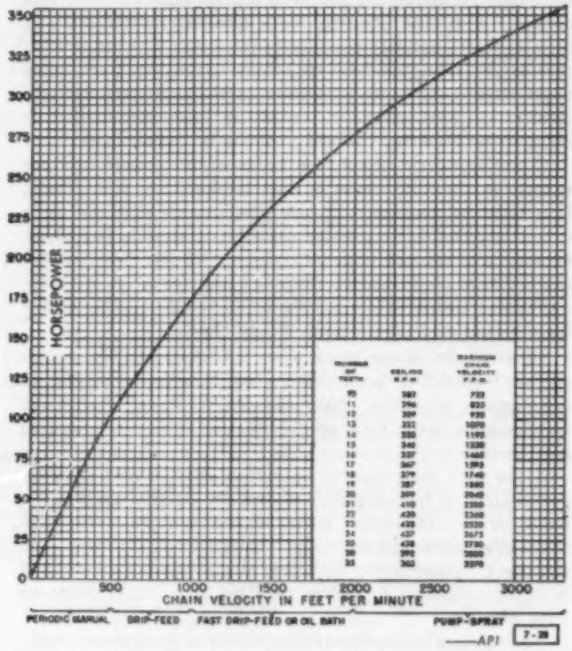


FIG. 20. Recommended maximum applied horsepower for No. 3 rotary transmission chain.

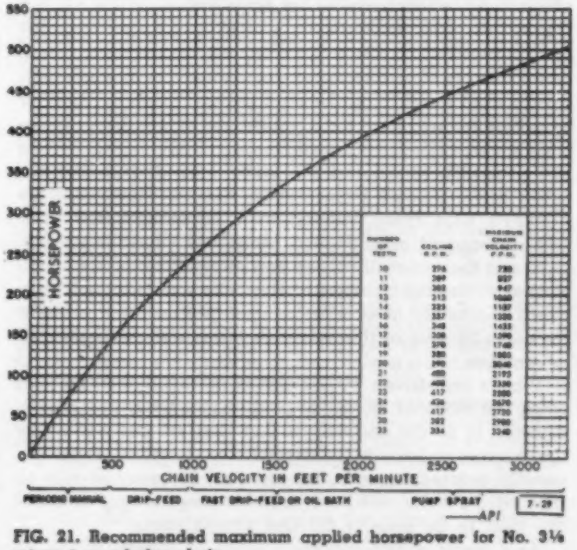


FIG. 21. Recommended maximum applied horsepower for No. 3½ rotary transmission chain.

Power Transmission Means

In the transmission of power within the modern drilling rig three basic means are utilized; chains, v-belts, and gears. Other means, such as flat belts, have been used in the past and special means such as friction drives are sometimes used today, but all of these are fairly uncommon.

Roller Chain. Roller chain is by far the most popular means of power transmission used on a drilling rig. Two typical applications of roller chain are seen in Fig. 5 where a double strand of 1½-in. pitch chain is used as a reverse drive within a selective transmission and a single strand of motorcycle size chain is used to drive a lubrication pump. Some advantages of roller chain drives are:

1. Efficient operation — 98 per cent.
2. Positive drive, without slip.
3. Compact drive, requires relatively little space.
4. Requires no initial tension.
5. Can provide great speed reduction (10 - 1).
6. Needs slightly less perfect shaft alignment than gears.
7. Is easy to maintain and replace.
8. Is not affected by reasonable changes in climate or surroundings.
9. Is durable.
10. Can be run in either direction.

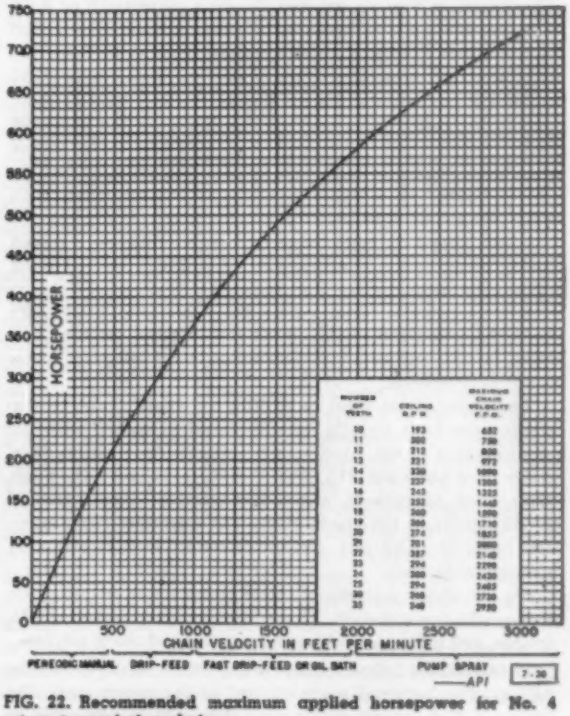


FIG. 22. Recommended maximum applied horsepower for No. 4 rotary transmission chain.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

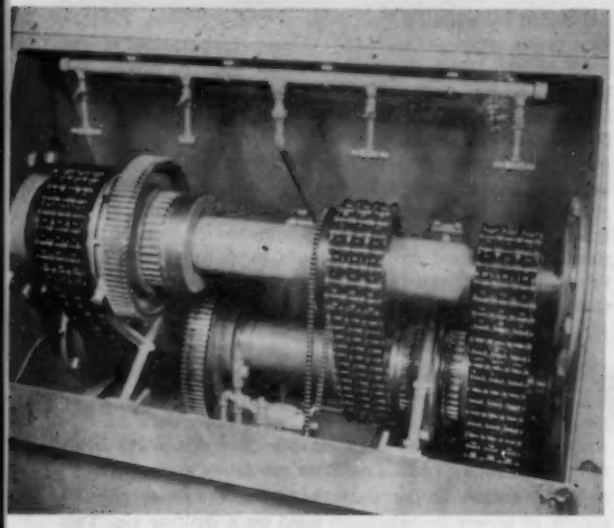


FIG. 23. Steel roller chain on drawworks transmission. *Link-Belt*

On older drilling equipment the drives were subjected to high chain pulls and occasional heavy shocks during clutch engagement. This chain was also subjected to rather severe usage in terms of alignment, lubrication and maintenance. These difficult conditions led to the development of large, heavy, high quality chain that was standardized by the American Petroleum Institute in their sizes, number 3, 3½, and 4, with these sizes approximately representing the pitch of the chain. The API, in their Standard 7, provides graphs covering the recommended application of these chains in regard to horsepower, chain speed, and recommended lubrication. Copies of these three graphs are reproduced in Fig. 20, 21, and 22, with permission of API.

Inspection and comparison of these graphs shows that as the pitch of the chain decreases from 4 to 3-in. the maximum recommended chain speed increases from 2950 to 3270 ft per minute. This is due to the fact that as chain speeds increase the impact of the chain on the sprocket tooth, rather than chain pull, becomes the main source of failure. Thus it is important to keep the chain as flexible and as "light" as possible and this is accomplished with multi strands of light, short pitch chain.

As the speed of chain drive has been continually raised during recent years the majority of chain drives on most modern internal combustion powered rigs now uses chains of 2½-in. pitch or less rather than the long pitch API chain. An exception to this is the rotary table drive as this drive is still subjected to extremely hard usage at relatively slow speeds.

The roller chain used in drilling rig main power transmission drives is usually manufactured in accord with the requirements of the American Standards Association. Normally used sizes are 2½, 2¼, 2, 1¾, 1¼, and 1-in. pitch. With some exceptions, chain nomenclature when divided by 80 results in the chain pitch. For example, chain number 140H is (140/80) 1¾ pitch chain with heavy (H) strength side bars.

Fig. 23 shows a precision steel roller chain installed on drawworks transmission. These are manufactured in single, double, and multiple widths and a variety of chain pitches.

Maintenance. Lubrication of roller chain, as shown on the API graphs, becomes more critical as the speed increases. On most high speed drilling rig drives it is advisable to provide force feed lubrication to the chain from the inside of the drive so that centrifugal force will throw the lubricant through the chain and not off the chain. Some designs now introduce the lubricant into the sprocket through the shaft and thence out the root diameter of the sprocket into the chain. Actual lubrication is extremely important to good chain life and the recommendations of the manufacturer should be followed as closely as possible. Particularly troublesome have been such items as the incorrect oil; lack of oil, or clogged lines resulting from dirty filters, and sludge or rags and soft rope getting into the system.

During installation the alignment of roller chain drives should be rechecked. Also some slack should be allowed on one side of the chain, preferably the lower side. A pretensioned drive is detrimental to both chain and shaft bearings. However, excessive slack is also harmful due to chain whip and possible tooth disengagement. On long drives it is sometimes possible to remove a link to shorten the drive if stretch-wear provides excessive slack. The chain should, of course, be kept as clean as possible and washed with solvent if it should be subjected to grit or dust; after washing, the chain needs to be relubed.

Worn sprockets should be replaced, if possible, or reversed so that the chain is not "hooked" by worn teeth. If it becomes necessary to use less strands of chain on a drive designed for a greater number of strands it will be necessary to replace or reverse the sprockets when the full multi-strand chain can be obtained and installed. This requirement results from uneven tooth wear and the resulting unequal load on the multi-strand chain.

Silent Chain. Silent chain types of drives combine some of the features of both roller chain and gear drives. In comparison to roller chain the silent chain type drive utilizes gear teeth type sprockets and a semi-articulating mesh action.

Along with their quieter operation, silent chains may be considered to be adaptable to higher speeds than roller chain drives. However, silent chains require very good shaft alignment and very rigid installations. As they also require a tighter drive with less slack than roller chain it is often necessary to utilize take up type installations on long drives.

The general maintenance-lubrication procedures mentioned in regard to roller chains are applicable in the main to silent chains. However, one trouble with such chain is its lack of standardization and, as a consequence, each chain manufacturer should be consulted in detail for the lubrication and maintenance instructions concerning his specific product.

V-Belts. In the drilling system V-belt drives are primarily used for driving the mud pumps; however, smaller installations are used for a multitude of auxiliary drives such as generators, washdown pumps, oil pumps, etc. V-belts are generally considered for fairly long drives where a softer, more flexible connection is desired than would be obtained with chain. Among their advantages are their lack of required maintenance, shock and vibration absorption, and their overall rugged and dependable action.

Due to the light weight of the belts and the light open guard commonly used, V-belts are often used on portable packages because of the weight factor as well as their other advantages.

V-belts are driven by the action of the sheave grooves upon the sides of the belt. In fact, the belts are always selected to fit the sheaves so that they do not bottom in the grooves and touch the sheave root diameter. Belts are usually ordered, stored, and installed in matched sets so that all the belts will be of equal enough length to allow the load to be equally divided among them.

As a result of the important usage of V-belts in the oil

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE

fields, the API has developed considerable valuable data concerning their selection, application and use. This information is published in API Standard 1, and the following information on installation, maintenance, and operating practices is reproduced with the permission of the API.

"21. INSTALLATION. Proper attention should be given to the following items during the installation of V-belts.

a. Sheaves should be aligned and shafts should be parallel and free to rotate.

b. V-belts should never be run on or forced over sheaves. Centers should be slacked off until belts can be placed in the grooves by hand. Before initially tightening any set of belts, care should be taken to trace the slack in each belt to the same side of the drive. Tightening the drive before this is done can result in damage to the belts. Tension in V-belts should be such that when the drive is idle the belts appear snug, and when drive is under full speed and load, a slight sag is noticeable on the slack side. Vertical drives, extremely short center high ratio drives, and drives carrying pulsating loads need additional tension.

"22. MAINTENANCE AND OPERATING PRACTICES. V-belts require very little maintenance, but lack of attention to the following items will result in reduced service life.

a. Lubricate the bearings of sheave and idler shafts to prevent freezing.

b. Maintain operating tension by periodic adjustment of centers of idlers. Changes take place more rapidly when new belts are first installed, and these should be checked after 24 and 48 hrs of operation.

c. Keep the shafts parallel, sheaves in alignment and running true. Excessive wobble or eccentricity may result in vibration and overload and cause damage to belts.

d. Do not permit the belts to rub or strike splinters, spikes, sharp edges, or belt guard while operating.

e. Keep belts and sheaves reasonably free of lubricating oil and other foreign material.

f. Belt dressing should not be used with v-belts. If slippage occurs due to an oily or dirty condition of belts or sheaves, both the belts and the sheaves should be thoroughly cleaned with a cloth and volatile cleaning fluid.

g. The practice of using a pipe wrench to turn a sheave by hand should be avoided, as the groove ribs can be severely damaged.

h. Extremely rough, broken, or chipped grooves result in reduced belt life. Worn sheaves should be regrooved.

i. Dampen impulse loads as much as possible by balancing the equipment. Belt vibration may often be reduced or eliminated by slight changes in speed or tension.

j. If the tension section of a belt is ruptured by installation, accident, or use, the condition is evidenced by a "necked down" section, and such a belt should be removed from the drive.

k. Belts should not be allowed to run turned over in the sheave grooves. The tension section of a turned belt is severely stressed and therefore subject to rupture or permanent damage.

l. Only matched belts should be used on multiple drives. New and used belts should not be used in the same drive. Used belts which are still serviceable should be matched to make full sets.

m. Belts of different makes should not be mixed in the same drive.

n. V-belts should be stored in a cool, dry area free from direct sunlight or heater contact.

o. Guards should be kept in position and properly ventilated and drained.

p. Provision should be made for applying tensions, either by adjusting the center distance or by the use of idlers. If idlers are necessary, it is best to use a grooved sheave on the inside of the slack side of the drive, with a diameter not less than the minimum recommended for drive sheaves.

q. For pump drives with separate skid mounting, it is recommended that the pump skid be mounted in a cradle equipped with screws or turnbuckles to provide ample take-up for center adjustment. The cradle should be anchored to the substructure base and arranged to float on a pad of such size and design as to resist shifting and settling out of alignment.

r. Wide and narrow grooves resulting from poor machining or uneven wear in service will result in "differential driving" and reduced belt life. Such sheaves should be regrooved or replaced.

s. Some V-belt drives on slush pumps exhibit strong vibration of the belts, thus contributing to premature belt failures, particularly on drives employing flat (back-bending) idlers on the slack side. On many such drives the difficulty has become overcome by the use of devices which dampen the vibration of the belts on the slack side."

Poly-V drive is a single unit belt in which the strength member covers the entire width of sheave and eliminates V-belt matching and turnover.

Gears. Gears find their greatest use where compactness of design, quiet operation and large speed variations and ratios are required. There are seven types of gears that are used in the oil fields. These are:

1. Spur gears.
2. Helical gears.
3. Herringbone gears (double helical)
4. Bevel gears.
5. Spiral gears (including Hypoid)
6. Worm gears.
7. Rack and pinion.

Of these the helical and herringbone, and the bevel and spiral gears are probably the most commonly used in modern drilling equipment for power transmission and speed changing. The spiral and bevel gears and their many derivations and combinations are familiar in their application to rotary tables. The herringbone and helical gears are used in many rig selective transmissions and mud pumps, and probably find their greatest quantity application in pumping units.

The herringbone gear is actually a double helical gear cut together so that the end thrust obtained with a helical gear will be cancelled out. Fig. 7 showing the speed diagram of the 900-hp drilling rig also shows the use of herringbone gears in a selective transmission, and in this case the gears are used to obtain a reverse speed.

Maintenance. The alignment of gears is extremely important and any gear installation must be very rigid to forestall any "working" that might allow the gears to get out of line. Dirty, rough, or operations involving severe shocks, are also quite bad for gear installations.

Gears are usually considered long life installations if properly engineered and maintained. Along with general cleanliness and alignment, lubrication of the proper type and amount should be watched carefully. The recommendations of the manufacturer in regard to all maintenance and especially lubrication should be followed closely.

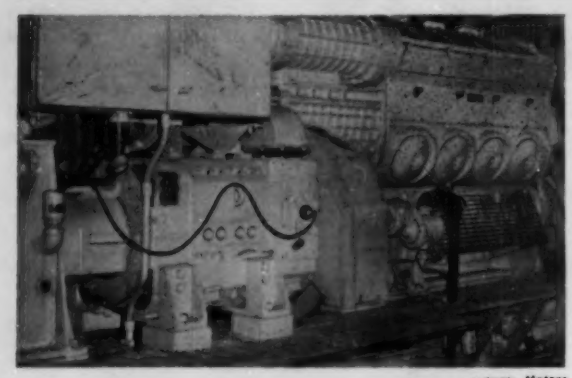
Diesel Electric Transmission

Diesel electric power has been applied to oil well drilling for some period, however in recent years it has been utilized in an increasing number of applications. As the power packages, including generators and motors, serve to both transmit and control the original diesel engine power the over all diesel electric system acts as a power transmission in that it replaces the main chain compounding transmission and a good portion of the mechanical controls with electrical transmission and electrical power controls.

The majority of recent new diesel electric applications utilize traction type systems similar to the equipment used in railroad diesel electric packages. As a result of the infinite intermediate power made available by electrical control and the smooth application of this power the actual output of a diesel electric system is very similar to the controlled power output of steam. As a consequence of this, diesel electric power finds its optimum application in combination with modernized steam drawworks.

As the result of being able to efficiently locate the prime power package some distance from the drawworks and pump locations, the main application of diesel electric rigs has been in offshore drilling where the flexibility of equipment location is so important to the design requirements of space, structural strength, and factors of naval architecture. Further, the size of the offshore drilling rig is usually in a range where it is economically feasible to consider power packages of the sizes available from the diesel electric equipment manufacturers.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.



General Motors

FIG. 24. Diesel engine and generator kit on diesel electric rig.

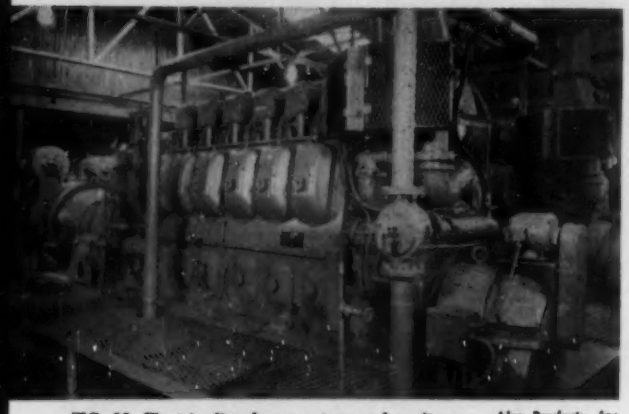


FIG. 25. Electric diesel generators and exciters. Alco Products, Inc.

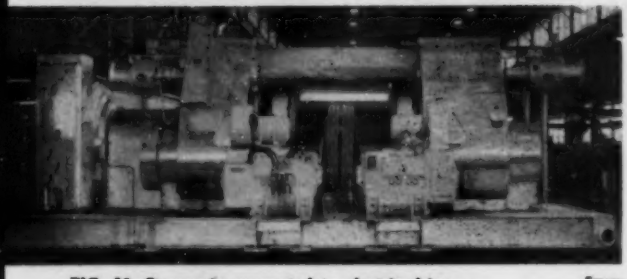


FIG. 26. Steam rig converted to electric drive. Ensco

Control. The majority of diesel electric applications are basically similar although many differences in the operation are utilized. In one package a diesel engine prime mover powers a main electric generator and an additional generator for providing control power. The main generator is wired to the main electric motor at the drawworks through an electrical control system. The system uses the control generator to control the power of the main direct current motor at the drawworks. One type control used is a constant speed-variable voltage system in which the diesel engine operates at constant speed. Other systems have been used in which the engine speed is controlled. The manual controls are located at the driller's position.

Two basic types of control are available: 1) Controlled field excitation and 2) controlled armature voltage; a combination of these two types of control can also be arranged.

In both systems a relatively small amount of initial power serves to control the main power output over a wide range. There is usually some provision for at least step control of the engine so that continual low power requirements can result in a lower throttle setting and reduced fuel consumption. The control of engine speed acts to control main generator speed and consequently control armature voltage, which is in addition to the controlled field excitation of the dc motor, providing a combination control system.

Like the special drives previously discussed, the diesel electric rig provides some important advantages in controlled power at the drawworks. Infinite intermediate "gearing" is made possible as is maximum torque setting and control, plus smooth application of power. The reversing of the motor and the ease of complete "de-clutching" by electrical control further enhances the diesel electric rig. With the control circuit "cut" there is no connection between the input to the direct current motor and the drawworks. With the control circuit reversed the direct current motor will provide reverse power upon demand.

This combination reduces the number of speed changes required and in large rigs the 4-gear changes available within the modernized steam drawworks are sufficient for optimum operations. The lack of a reverse gear in the steam drawworks is not a problem due to the reverse function of the electric motor.

Application. A photograph of a modern 4-speed steam drawworks to be used in an offshore drilling rig with diesel electric power is shown in Fig. 26. Two 600-bhp (continuous) electric motors are used. The electric motors are powered by the remotely located diesel engine-electric generator packages and will be controlled through control generator power, as shown in Fig. 25.

Often the electric equipment is provided with both heating (drying) means in addition to air circulation for cooling due to the dampness of offshore locations and the ensuing corrosion problems. Dry air type scavenging systems have been used at times where special conditions or equipment requirements necessitated. Some of these overhead ventilating ducts are shown in Fig. 24.

The mud pumps are usually powered by separate dc motors and the rotary table is either chain driven from the drawworks or powered by its own dc motor as an independent unit. The control for these units is furnished by the power of the control generator through the control system from the driller's position. Auxiliary electrical and engine throttle controls can be easily installed at the pumps or table packages as required.

Conclusion

The design and, in fact, the selection of any system of power transmission must be based as much on experience as on basic engineering principles. As a result of this it is impossible to say which of any way of doing a particular job of transmitting and converting power is best for any but a very special group of requirements. Further, what is sometimes considered "best" today will not satisfy the changed requirements of tomorrow. As in other industries, our drilling business is benefitting from advanced technology and experience both in available equipment and actual operations. These advances are evidenced in such operational trends as increased pumping requirements as a result of jet bitting, use of drill tubing, new completion practices, gas and air drilling, etc. It is apparent that power transmission, whether from the old rope drives to the present V-belts, whether from the spur gears to the herringbone gears of today, or from the straight mechanical transmission to hydraulic drives, is changing too. It is therefore imperative that both manufacturer and user be ready to accept such changes in transmission design as are dictated by an advancing industry so that the end product can be continually improved in terms of final drilling efficiency.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE

Better Protection

with 'INCOR' Sulphate Resistant Cement

...Less Cost, Too

●First used nearly thirty years ago in the East Texas field, then rapidly spreading throughout the Panhandle fields, Central and West Texas and other areas, 'INCOR' 24-Hour Cement reduced the cost of "waiting on cement," saving lost rig time and delayed production.

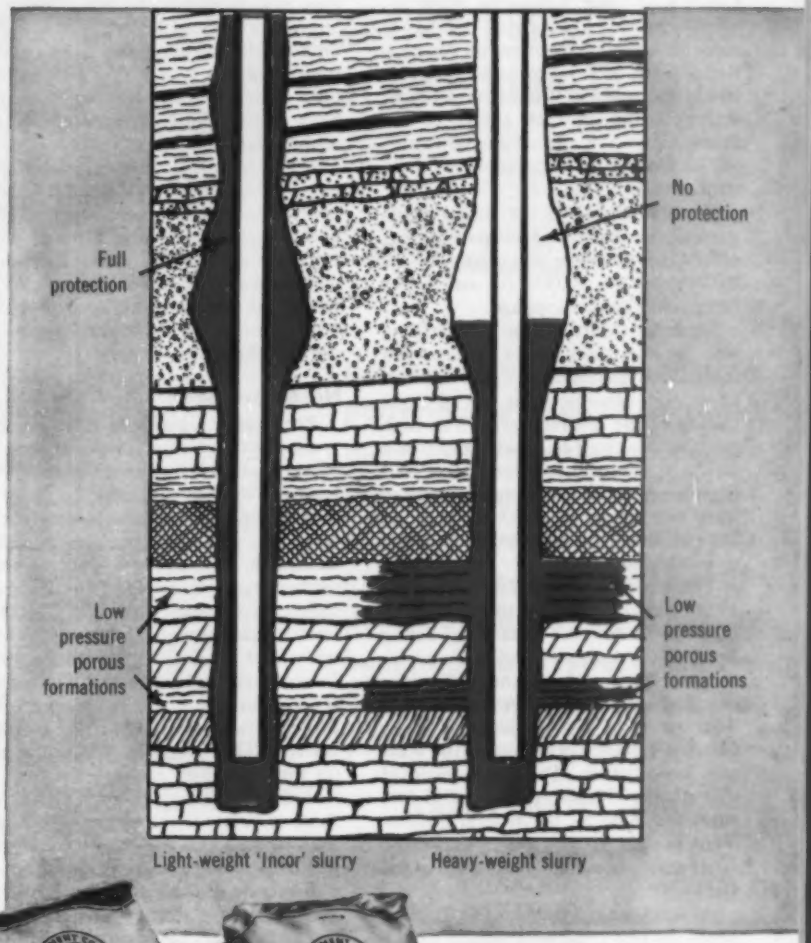
Always-dependable 'Incor' performance has resulted in steady year-after-year increases in the use of America's first high early strength or so-called 'quick-set' cement.

And now 'INCOR' SULPHATE RESISTANT CEMENT—'A DUAL PURPOSE OIL WELL CEMENT' is in steadily widening demand. It provides protection against sulphate attack where needed.

In addition, and of more significant importance in some areas, is the greater yield of slurry per sack of cement—lower cost per cubic foot of slurry back of the casing—lighter slurries that assure better circulation with added protection and dependable high early strength at all times.

There's a Lone Star Cement for every oil well condition—just select the one that fits your job. Performance counts!

*Reg. U. S. Pat. Off.



LONE STAR CEMENT CORPORATION

Offices: DALLAS • HOUSTON • ABILENE, TEX. • NEW ORLEANS • KANSAS CITY, MO. • BIRMINGHAM • ALBANY, N. Y. BETHLEHEM, PA. • BOSTON • CHICAGO • INDIANAPOLIS • NEW YORK • NORFOLK • RICHMOND • WASHINGTON, D. C.

Tidelands Ownership Question Stymies New Drilling

C. R. Graham
Field Editor

Federal government, Louisiana leasing and "new drilling" ban idles 30,000 oil workers

FEDERAL and Louisiana state officials are being urged by oil officials to come to a quick agreement on resumption of Gulf offshore oil and gas operations. Stalemate of Louisiana offshore activity is the six-week old U. S. Supreme Court ban against any new drilling or leasing on a disputed 7½-mile strip of Gulf tidelands.

Representatives of 18 major companies have moved to press government officials to take some action to put back to work some 30,000 oil employees being idled by the stoppage.

Supreme Court ban on new drilling was put into effect until Louisiana and the federal government could reach a temporary agreement on the administration of the disputed area. The high court action came as an aftermath of a series of charges, countercharges and an injunction surrounding a proposed lease sale by the U. S. Department of Interior in which lease block ownership was in question.

The lease sale, scheduled May 15, 1956, was cancelled on the day of the auction. Order was issued by acting Secretary of Interior Fred C. Aandahl, to be effective until the difficulties "could be ironed out." A state injunction suit by a district judge in Lake Charles, Louisiana, prompted the lease sale cancellation. The judge claimed that about 350,000 acres of 511,000 acres for lease by the federal government at this auction were within the 10.36-mile "historical boundary" of the state.

At this time the Interior Department asked the Department of Justice to step in and take "appropriate legal action" against the injunction issued by the Louisiana judge. Instead of acting in the manner expected, the Supreme Court issued the ruling to stop all activity until a definite settlement on the disputed area could be made.

On June 11 the Supreme Court called a halt to all leasing and new drilling in the "twilight zone." At this time it was thought that only escrow agreements between Louisiana and the U. S. government would be necessary to lift the ban and again permit leasing and drilling to continue. The state rushed to pass new legislation to put in escrow any receipts from leasing the area — until a definite ruling was given on the state's boundary. All this failed, and until now new plans and proposals by both parties have been fruitless in settling the dispute.

Until June 21, Louisiana did not have any law setting aside funds of oil companies paid as bonuses for leases in the disputed area. Bonus money paid for leases sold in federal auctions were automatically placed in escrow. As a result, oil operators as a whole have been more reluctant to seek leases at the state-held auctions.

No Accord Seen

Problems multiply as time passes, and accord between state and federal officials seems little closer. Several proposals have been suggested.

A federal government proposal offered in mid-July, but rejected by Louisiana, was the most seriously considered plan yet made. This proposal called for the setting aside of all revenues realized thus far from oil and gas operations in the disputed area, plus future revenues from royalties, lease rentals and bonus bids, in return for the resumption of the leasing and drilling activity. This proposal would also set up three offshore zones — the first to include all submerged lands inside the three mile limit, the second including the disputed area, and the third in the depths beyond the three-league limit.

Rejection of the U.S. plan, according to Louisiana Attorney General Jack Gremillion, was based on several of the financial requirement provisions with which Louisiana could not comply.

"Shut 'em Down"

Louisiana Conservation Commissioner John B. Hussey declared that all the offshore reserves should be assigned to a military and naval reserve — and withdrawn for use in time of national emergency or oil shortage. The commissioner has indicated that he is not only refusing to issue drilling permits for the disputed region, but is issuing none within Louisiana's 3½-mile limit — except by written authorization of the state attorney general.

Hussey was quoted as saying that "The entire offshore operations should be shut down completely, until they get this boundary dispute settled."

Coastline Boundary Set

Key to the entire problem may be in establishment of a definite location of Louisiana's coastline. In many places between Sabine Pass and the mouth of the Mississippi River the line of difference is as much as five miles.

Because of the thousands of inlets, bays and peninsulas along the shore, agreement has never been reached as to just where the line is. Louisiana's state mineral board appointed a geologist, an engineer, and an attorney to meet with a trio representing the U. S. Department of Interior. The state board made clear that the committee would do no more than study proposals and make recommendations. These committees will work aside from the present negotiations between Interior Department and state officials on an interim agreement on the offshore leasing rights.

Effects of the new drilling ban may be far reaching beyond the immediate unemployment situation—unless quick settlement is made. One report states that more than 100 leases are due to expire in the Gulf in the next 12 months. Delay in drilling on these leases could mean that many of the blocks would be forfeited as undrilled and unproductive. To repurchase the same lease would mean paying several hundred times the original purchase price of $5 per acre, the going price in the early days of offshore leasing in 1947 to 1949. Last July, average price paid at a federal offshore auction was $400 per acre. Several operators have indicated that they will need to speed up activities if they will be able to drill on properties now held.

As a result of drilling pressures being placed on the operators, farmouts in Lousiana tidelands are becoming increasingly numerous. Many reportedly "good deals" are being turned down in the troubled Gulf waters. ★ ★ ★

MORE BARRELS per dollar spent

. . . you can make more oil for every dollar invested when CABOT quality pumping units are working for you!

Designed for top production performance round-the-clock, month after month, Cabot quality pumping units are unmatched when it comes to cost of operation—and, barrels of oil pumped. Adjustable crank or beam-balanced types available in a size to meet your need. *See your J & L Supply man.*

CABOT SHOPS, INC.
PAMPA, TEXAS

ON THE SPOT FIELD SERVICE

Cabot now offers its OWN 24-HOUR PARTS AND MAINTENANCE SHOPS at Odessa, Houston, Alice, Kilgore, Compton, Great Bend, Seminole, Casper, Pampa and Tulsa.

CABOT
SHOPS, INC.
PAMPA, TEXAS
"ON THE SPOT" FIELD SERVICE

DIVISION OF CABOT SHOPS, INC. FRANKS

Considerations for . . .

Single Zone Well Completions

How do you complete your well — cable tool or rotary; "permanent" or conventional type completion methods? This approach to single zone completions clarifies advantage and use of the many methods available.

C. L. Rawe
Senior Production Engineer
Atlantic Refining Company, Dallas, Texas

AN operator must make many important decisions during the planning, drilling and completion of a well. He must decide where to drill, how to drill, how to protect the well and how to complete it. The method of completion may determine the ultimate profit realized from the venture. For profitable operations, optimum well conditions must be obtained at a practical cost.

The well may be drilled by cable tool methods, rotary methods, or a combination of the two. By any method of drilling, the completion programs have common objectives: (1) that of obtaining sufficient penetration of the zone; (2) the exclusion of extraneous fluids, gases, or materials from the producing interval; (3) methods that will not damage the zone; (4) sizing of the equipment for flowing or artificial lift equipment to deplete the zone; (5) sizing of equipment to accommodate future remedial operations.

Factors that tend to alter completion methods from one field to another or from one area to another are the drilling methods used, type of producing zone, type of reservoir drive, physical properties of the zone, probable life of the well, the well stimulus program contemplated, and corrosion problems that may be encountered. These factors, although complex, are usually least difficult to solve in the completion of a single zone well. The single zone completion is the most common type of completion and is one that may be applied in a single zone field or for completion of one zone in a multiple zone field.

Methods of Drilling

Since the completion program should be planned in advance, the drilling method offering the greatest number of advantages should be used. The drilling program should be both a means of getting to the formation and a completion tool. As such, an operator may complete his well by the cable tool method, rotary method, or a combination of the two. The cable tool method was the first generally accepted method of drilling and is still used extensively in a number of areas; however, today more wells are completed by the rotary method.

The Cable Tool Methods

Cable tool methods, although very primitive, were used by Drake to drill his first oil well in Pennsylvania. These methods spread to West Virginia, Ohio, Illinois, Oklahoma, Kansas, New Mexico, North and West Texas, and other areas that are essentially hard rock areas. It is in these areas that cable tools are found most applicable to completion methods today.

Cable tool drilling depends upon the principle of reciprocating a drilling bit on the bottom of the hole in order to penetrate the formation. Drill cuttings are removed from the hole by bailing. Fluids in the hole are generally kept to a minimum both for ease in bailing and for tool action. Therefore, the cable tool method is ideal for drilling low pressure zones, zones that are easily damaged by mud, or zones that have severe fractures. In any of these cases a light fluid head is desirable.

This method has received its greatest use in shallow applications above 3000 ft. Some creditable completion and remedial work has been done at depths of 5000-7000 ft and in isolated instances deeper. Cable tools are not readily adaptable to the drilling of incompetent beds, sloughing shale sections, or in areas where multiple water or producing zones of great magnitude are encountered. Thus, these methods are not adaptable to extensive drilling in coastal areas or to wells of great depth.

Rotary Methods

As noted above, rotary type drilling is used more universally today than cable tool methods. The rotary method consists essentially of rotating a drilling bit on the bottom of the hole by means of drill pipe which extends from the surface to the bit. It penetrates the formation by the rotation of the bit, the weight placed on the bit and the hydraulic action of the drilling fluid. Cuttings are removed from the bottom of the hole by circulation of fluids, gas, or air—or a combination of fluids and gases. In most operations the media circulated is pumped or blown into the inside of the drill pipe and displaced through the bit. It is returned to the surface, carrying the cuttings, through the annulus between the drill pipe and the walls of the drilled hole. A circulating media must be maintained, in most cases, to continue drilling operations.

The circulating media, depending upon its characteristics, can aid in the completion of the well by controlling formation fluids as in the case of zones of high pressure or be detrimental to a zone because of low pressures or characteristics of the zone. Thus, in completion procedures the type of circulating media used is an important factor. Today, however, industry can select circulating media for rotary operations ranging from gas and air to drilling muds designed for drilling wells where 28-32 lb per gal mud is needed to control formation pressure.

The operator now has some basis for the selection of a drilling method to fit his well conditions. If he is in hard rock country, has shallow or relatively medium depth wells, low pressure zones, lost circulation problems or formations easily damaged by drilling fluids, then he should consider the merits of drilling the well with cable tools. As an alternate, he could drill to the top of the producing zone with rotary and complete the low pressure zone with cable tools.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE

If the operator is in an area where multiple zones of water, oil, or gas exist, has thick zones of incompetent material, high pressure zones at any depth, then he would be wise to select the more universal method of drilling, which is the rotary method. Having selected the rotary method, he would select a drilling media of fluids, gases or air to obtain maximum benefits from these various materials.

Mechanical Structure of the Well

Drilling methods having been selected, the mechanical structure of the well should be considered. Basically, this consists of a system of piping set into the ground at strategic points to facilitate the drilling of the hole, the protection of the hole, or for production. In most instances, each string of pipe used in the system extends from the point at which it is set to the surface as one continuous unit. (See Fig. 1.) This system of piping, known as casing or tubing depending upon its function, has or should have adequate surface controls at all times. While drilling a well, these controls are in the form of casing heads, blow-out preventers and valves. While producing the well, they are in the form of proper casing heads, tubing heads, and valves of the Christmas tree. This equipment may be obtained having test pressures as high as 30,000 psig. The ramifications of the placement and the different types of equipment that may be used to control the well at the surface are so diverse that no attempt will be made to discuss this aspect.

In general, the well's protective system consists of a relatively shallow surface casing string that protects drilling operations from sloughing conditions of surface formations (See Fig. 1), an intermediate string of casing which generally is set below fresh water sands or salt sections, a producing string of casing, and a string of tubing. Some variation in the number of strings used and their placement is required by certain local drilling conditions of depth, high pressure zones, or zones of lost circulation. Fewer strings may be needed than in Fig. 1 if the hole is shallow or drilling conditions are not severe.

The pipe known as the tubing string generally is used for producing the fluids from the reservoir but may in some instances be used to induce flow through the tubing-casing annulus. Normally the bottom of the tubing is run to within a few feet of the top of the zone. It may be suspended in the well with the casing-tubing annulus open, or it may be equipped with a packer or other equipment. The concepts of selecting the tubing completion will be discussed later.

Since completion problems are primarily associated with the producing string of casing, more reference will be made to it than to the other possible casing strings needed or used. This casing string may be set above the formation, in the formation, or through the formation. The method of setting casing may determine the success of the operation and costs of future production activities.

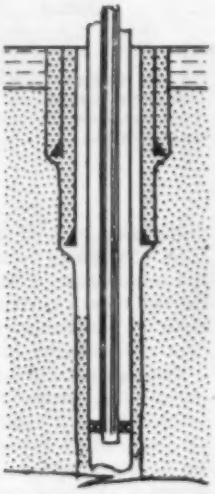


Fig. 1 — Typical casing program for a single zone well completion. This type program is used where an intermediate formation must be cased off. It includes: surface string; an intermediate or protective string and a production string.

Open Hole Completion

As noted above, the casing used as a production string or that string which will protect the producing zone, may be set above the producing zone (See Fig. 2). Since the

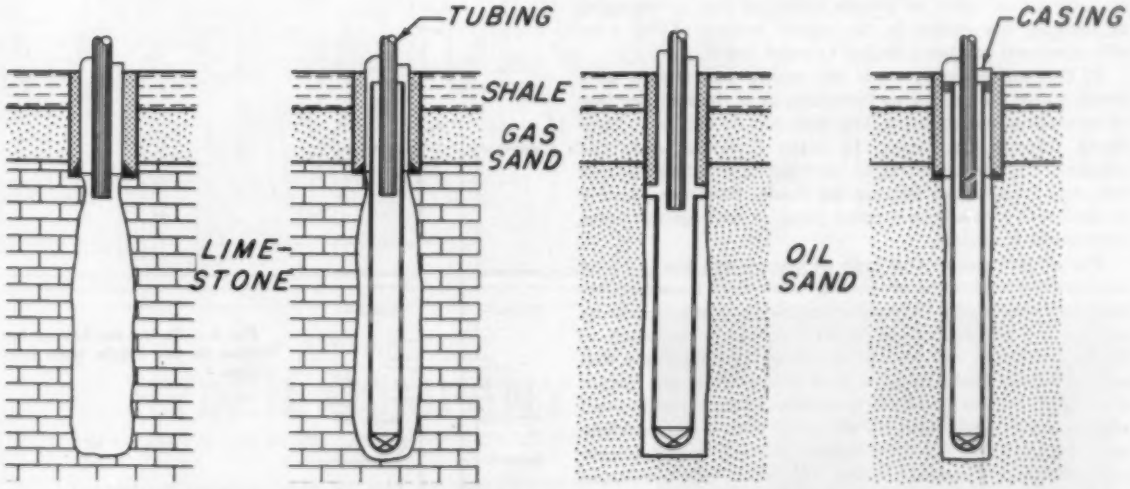


Fig. 2 — Type of open hole completions for single zones. The two at left are in limestone, with the far left diagram illustrating the most common type with nothing below the casing or tubing. The second diagram shows a protective screen or liner extending into the casing. Both diagrams at right are open hole sand completions. The first includes a liner, the top of which is set below the casing, and the far right diagram showing a similar arrangement where the liner was hung inside the casing.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

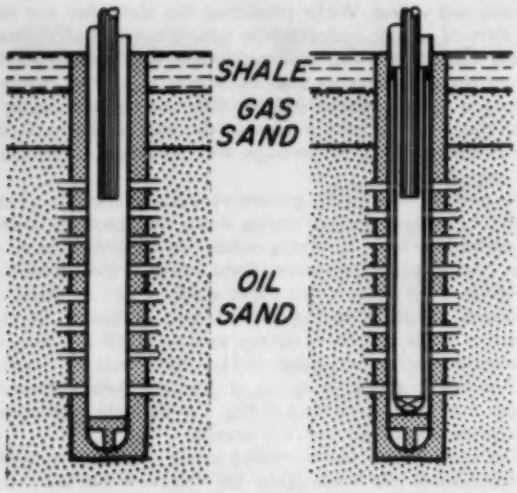
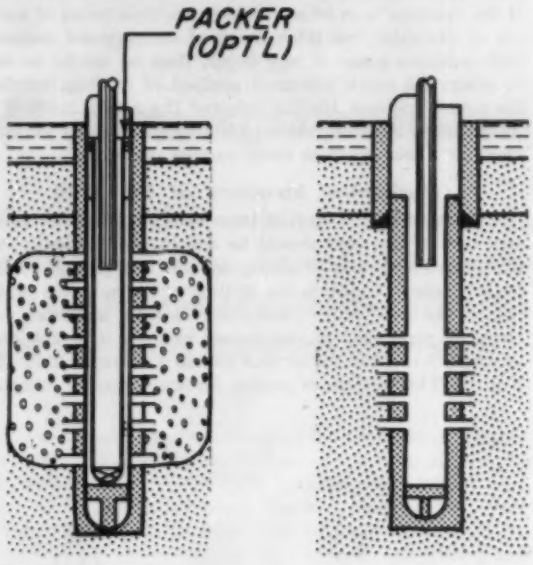


Fig. 3 — Single zone perforated completions where the productive string has been set into the formation. The most common is at left where the cemented casing has been perforated. The second illustration shows a screen or liner hung inside the perforated casing.



The third diagram is similar to the previous one except the zone has been gravel packed with a packer on the liner being optional. The completion shown at right is the type where both casing and liner are perforated.

producing zone is below the casing point, this type of completion is known as an open hole completion.

The open hole completion is the oldest type of completion used by the industry. Due to the lack of reasonably adequate perforating devices and other modern techniques, this method of completion practically was forced upon the industry until the early 1930's. About 1932 the advent of the perforating gun gave other means of completion more impetus. However, as the open hole method of completion is very adaptable to completions in low pressure zones, fractured or easily damaged zones, this method is used in both cable and rotary operations today. Two basic forms of this type completion may be selected—that of setting the casing at the top of the producing zone and drilling in with either cable or rotary tools, or that of swinging or hanging the casing in the upper section of the zone after the well has been drilled to total depth.

In the earliest operations the casing was landed at a depth above the producing formation or in the first few feet of saturation encountered. The well was drilled in to total depth through the casing. In many instances, only the weight of the casing setting on the landing shoulder isolated the zone from upper extraneous fluids. However, cement is used today to assure a more positive seal against these extraneous materials.

The advantages of this type of completion are: (1) an unrestricted bore in the producing interval; (2) some reduction in casing costs, (3) reduction of completion costs by eliminating perforating, in some instances as much as $2000 to $3000; (4) ability to change drilling fluids that are lighter or more compatible with the reservoir before drilling the main zone; (5) certain advantages in well stimulus processes such as shooting with nitro, marble-shooting, etc.; (6) ability to enlarge the well bore diameter in the producing zone if desired; (7) better hole conditions for gravel packing or running screens and liners.

Some of the more evident disadvantages of the completion method are: (1) inability to evaluate the formation before setting casing; (2) difficulty in picking the proper casing point without excluding too much of the producing zone; (3) setting in a top stringer of the producing zone and subsequently drilling shale sections which slough into the well bore; (4) difficulty in controlling fracturing operations; (5) difficulty in eliminating excessive gas production; (6) difficulty in controlling bottom-hole water.

The original open hole method of landing the casing above or in the first few feet of oil or gas saturation encountered had a number of problems. Some of these can be corrected by drilling to total depth and then hanging the casing in the upper section of the zone. Since the nature of the zone can be determined by bit cutting samples or by electric logging devices, premature setting of

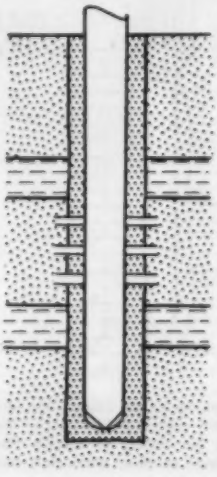


Fig. 4 — Casing set through formation in this single zone completion.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

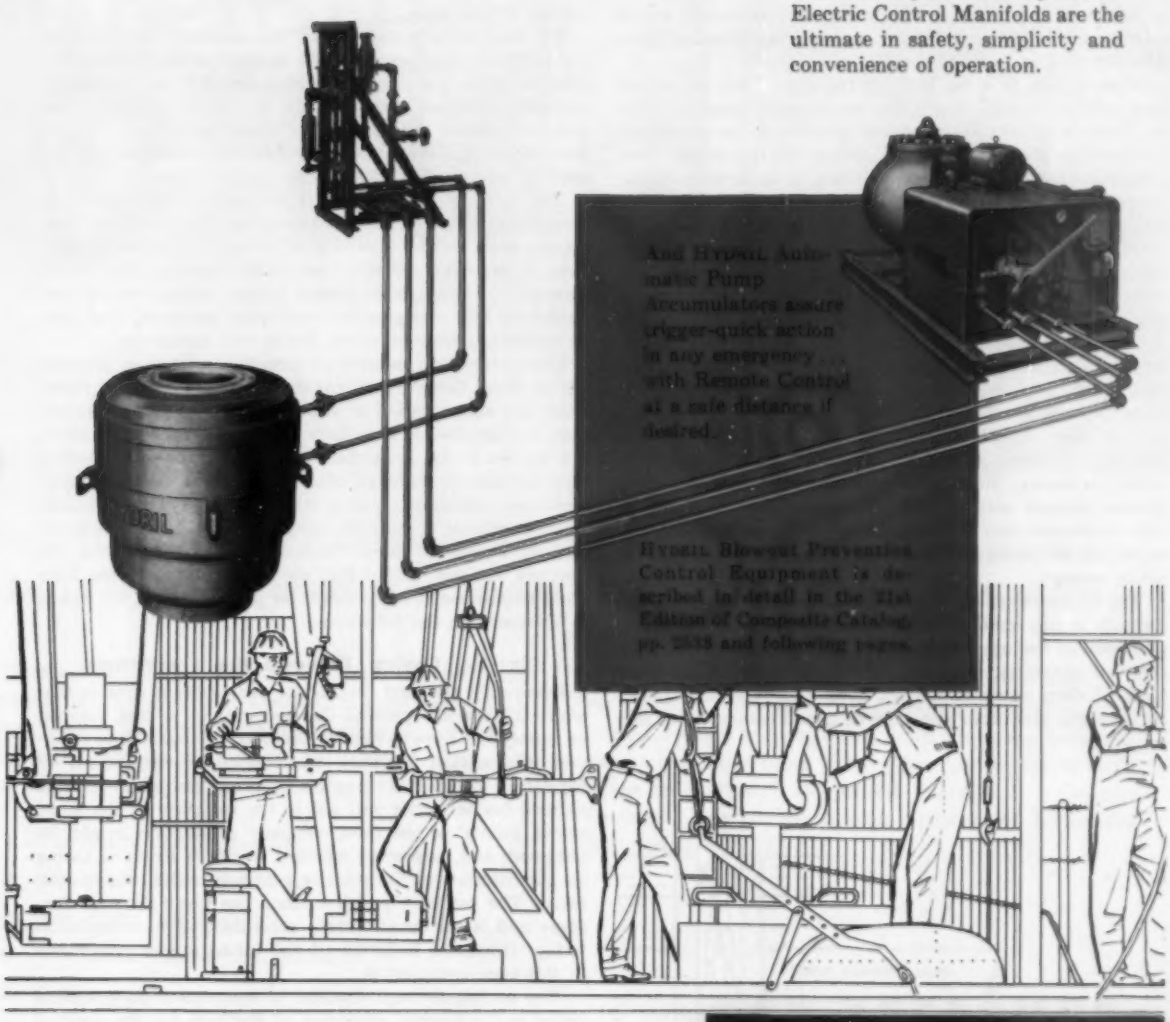
HYDRIL

TAKES THE "BLOW" OUT OF BLOWOUTS!

The HYDRIL System of Blowout Prevention Control provides faultless, foolproof control of threatening well pressures.

HYDRIL Blowout Preventers—Type "GK" or Type "MSP-2000"—are the most versatile of all blowout preventers.

HYDRIL Hydraulic or Hydraulic-Electric Control Manifolds are the ultimate in safety, simplicity and convenience of operation.


HYDRIL
And HYDRIL Automatic Pump Accumulators assure trigger-quick action in any emergency . . . with Remote Control at a safe distance if desired.
HYDRIL Blowout Prevention Control Equipment is described in detail in the 31st Edition of Composite Catalog, pp. 2513 and following pages.

HYDRIL COMPANY

714 W. OLYMPIC BLVD., LOS ANGELES 15, CALIF.

FACTORIES AT

LOS ANGELES; HOUSTON, TEXAS; YOUNGSTOWN, OHIO; ROCHESTER, PA.

HYDRIL SALES OFFICES

California: Bakersfield, Los Angeles, Ventura; **Louisiana**: Harvey, New Iberia, New Orleans; **Oklahoma**: Tulsa; **Pennsylvania**: Rochester; **Texas**: Corpus Christi, Dallas, Houston, Midland, Odessa; **Wyoming**: Casper, **Canada**: Calgary, Edmonton.

the pipe can be eliminated. Better knowledge is obtained on the gas-oil contact, so the casing can be set below the gas-oil contact for control of gas-oil ratios. Many of the advantages of the open hole completion are maintained, but the disadvantage of controlling bottom water is still present. In addition, the possible contamination of the formation by completion fluids and cements must be added to those disadvantages listed above.

Equipment and Materials Used in Open Hole Completions

No attempt will be made to discuss all the ramifications of equipment selection available to open hole completions. However, since protection of the producing interval from extraneous materials and the elimination of damage to the formation are cardinal functions, some mention will be made of the type of equipment and materials which may be employed to overcome some of the disadvantages inherent to this type of completion.

When casing is to be hung at the top of the formation after drilling to total depth, the use of metal-petal cementing baskets or formation packer shoes may be employed to minimize the danger of cementing the formation. This equipment tends to divert the cementing material from the selected producing intervals by placing a barrier between the cement discharge point and the producing interval. Acidizing, fracturing, or the use of de-blocking agents may be used to eliminate fluid damage or establish conditions more favorable to the flow of well fluids. Should shale sections or incompetent formations be encountered, liners or liners with screens or slots may be used to correct this condition. If sand is produced in the open hole completion, very favorable conditions exist for the setting of screens or for gravel packing to exclude this material. The area of flow available to the incoming fluid is greater in this type of completion than in perforations. It should be noted, however, that considerable evidence indicates greater success will be had with these operations if the hole is cleaned and the screens or packs are set with oil, water, or salt water rather than with a fluid having high solids content.

The elimination of bottom-water production, although difficult in any method of completion, requires particular attention in the open hole completion because of the difficulty of obtaining a good bond to the walls of the open hole. Modern usage of plastics, hydromite, Cal-seal, diesel-oil cements, and other specially designed cementitious materials have been used extensively in the open hole completions to remedy this situation. Many of these operations are conducted by placing the material on bottom with bailers, although conventional squeezing techniques may be employed. Use of the squeeze bailer has also found use in these plug-back operations.

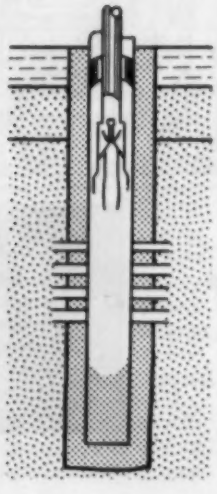


Fig. 5 — Permanent type well completion in a single zone. Tubing is set well above perforated zone to permit use of wire line workover techniques.

Setting Casing in the Formation

To overcome some of the disadvantages of the open hole completion, the practice of setting casing to total depth of the well but essentially within the one producing zone was adopted. (See Fig. 3.) This cured some of the disadvantages of the open hole completion but presented problems associated with perforating the casing, obtaining adequate cement sheaths behind the casing and again the problem of drilling and cementing casing without contamination of the zone.

The first wells completed by this method used mechanical perforators to perforate the casing; others used slotted pipe, or pipe with shop drilled holes and wire wrapped screens, to provide apertures through the pipe at the proper point to permit production. In these instances, attempts were made to place cement properly by methods formerly used in open-hole completions.

The advent of the bullet type perforating devices in about 1932 made this method practical. The resulting techniques were the forerunners of modern completion practices. It provided a method by which a greater part of the formation could be evaluated before setting casing and permitted the operator to selectively perforate the zone to exclude unwanted gases, fluids, and materials.

The perforation method of completion finds its greatest use in those fields where gas drive or solution type reservoirs are encountered, or where good geological information is available. It also finds application where oil zones are known to be separated from water zones by only a thin section of shale or other impervious rock. In these instances, sufficient bonding strength may not be obtained by the cements or plastics used to provide adequate isolation of the zones should they be drilled. Therefore, the barriers are not drilled but are used to protect the zone from bottom waters that might be produced, and the casing is bottomed in the formation.

Setting Casing Through the Formation

Obviously, the best method of evaluating a zone is that which affords an operator the opportunity to test, sample, or survey the zone to obtain complete geological and reservoir information. He may take advantage then of all information to plan his complete program. He can determine natural barriers that will aid in the isolation of the zone, select points where most efficient production might be obtained, and determine whether to risk a string of casing on the contents of the zone or continue to drill for deeper zones. The setting through method has these inherent features and is the most widely used method of completion today. However, isolation of the formation is paramount in this type completion.

The setting through method of completion as practiced today is the gradual evolution of methods for the need of those unfortunate individuals who drilled too deep trying to evaluate the complete zone of a well—and then struck water. Primary cementing operations were of such poor quality in the late 1930's and early 1940's in many areas of the Texas and Louisiana Gulf Coasts that many millions of dollars were spent in attempts to repair the primary cementing operation by secondary squeezing operations. In many instances, these squeezing operations completely or critically damaged producing zones so their ability to produce was curtailed.

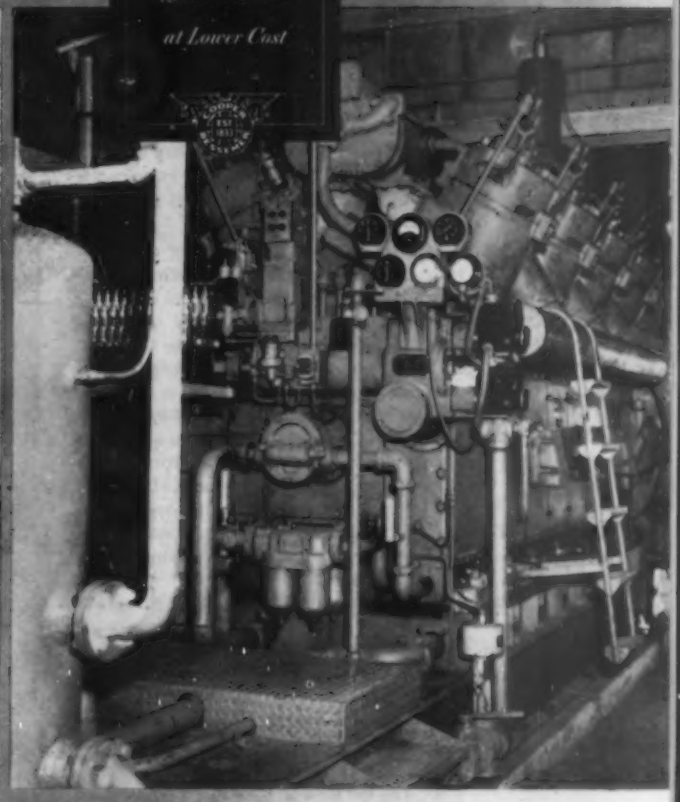
As the perforating guns improved conditions to permit

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE

One of three packaged GMXA's in the Eunice, New Mexico, station of United Carbon. These units, rated 550 hp at 450 rpm, efficiently compress a sour casinghead gas.

This view of the Eunice Station shows one of the 8-cylinder Cooper-Bessemers in place, while construction continues on the framework of the compressor building.

...Another Example of Efficient Power at Lower Cost



How UNITED CARBON sets a new LOW in compressor station costs with PACKAGED COOPER-BESSEMERS

Here are details on "big savings" in United Carbon Company's Eunice, New Mexico, natural gas plant. Three Cooper-Bessemer GMXA compressors, completely packaged, provide exceptional installation economies due to pre-assembly of the following:

1. The entire cooling system.
2. The entire lube oil system.
3. The entire fuel system.
4. The entire starting air system.
5. Entire gas piping to point of inlet and outlet.
6. Elimination of costly piping and design work usually necessary in this type of installation.
7. A simple, inexpensive mat type foundation to accommodate the skid-mounted GMXA compressor.

. . . . seven good reasons that help explain why the Eunice Station *cost less to build* than any of United Carbon's previous compressor installations.

If you have been searching for ways to cut costs . . . . yet maintain compressor dependability, availability, flexibility . . . you'll want to learn more about the latest advancements now being offered by one of the nation's oldest engine and compressor builders . . . Cooper-Bessemer. Contact the nearest office listed below for complete information.

MOUNT VERNON, OHIO

COOPER-BESSEMER

GROVE CITY, PENNA.

New York City • Seattle, Wash. • Chicago, Ill. • Houston, Dallas, Greggton, Pampa and Odessa, Texas • Washington, D. C. Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. Caracas, Venezuela • COOPER-BESSEMER OF CANADA, LTD., Edmonton and Calgary, Alberta, Canada.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

adequate perforation of casing, the introduction and use of scratchers and centralizers and the reciprocation or rotation of pipe improved primary cementing operations by the middle 1940's to the point that setting through techniques could be employed less expensively. Subsequent improvements in drilling fluids, cementing materials, and additives have also aided in this effort. As a result, isolation of zones can be obtained today without too much trouble except in some isolated areas or in the very deepest wells. Since isolation of the zone is of such great importance to the completion, a brief summary of some of the techniques should be made.

In general, there are three schools of thought as to the methods needed to obtain a satisfactory cementing operation for isolation of the formation. These may be classified rather loosely as those that depend primarily upon the distance between zones and the cement column afforded to protect the producing interval from unwanted fluids or materials; those that depend primarily upon the control of drilling fluids to produce thin, tough filter cakes that are conducive to good cementing operations; and those that depend upon mechanical aids such as rotating or reciprocating wall scratchers to aid in the removal of filter cake in the hole to obtain better cementing operations. The majority of the operators do agree that centralizers placed on the casing assist in centering the casing in the hole so that a more uniform sheath of cement is placed around the casing. Those operators depending primarily upon mud control to obtain good cement operations, start controlling the water loss of their mud generally at a shallower depth in difficult cementing areas than those that depend on mechanical aids. Those that use mechanical aids must reciprocate their casing during cementing operations.

Perforating

Perforation of the casing may be done by either bullet type guns or jet type guns. The latter types have gained in popularity in the past few years because of their ability generally to obtain greater penetration into the zone. There is an increasing tendency to perforate with the through tubing guns rather than the larger OD guns previously used.

The use of fluids that are more conducive to better perforating conditions has received considerable attention. The ability to perforate under low fluid heads, as can be provided using the through tubing guns, has improved the productivity of many problem wells and has great promise for much wider application. In this method of completion the pressure due to the hydrostatic head at the time of perforating is reduced to a point below the pressure expected in the zone to be perforated; therefore, an immediate influx of fluid from the reservoir to the well bore is experienced at the moment of perforating. This tends to clean the perforated hole of mud and debris from the bullet or jets, etc. Since the well is ready to be produced at this time, mud is not left standing on the perforated interval after perforating as would be the case if the older conventional methods of perforating and then running tubing were used.

Selection and Use of Tubing

The tubing string in a well has several functions. It is used as a conduit for fluids or gases from the producing interval to the ground level in a single completion well. It aids in the artificial lift problems by assisting or containment of artificial lift equipment such as gas-lift valves, hydraulic pump equipment, etc. When set on a packer it constitutes a means of protecting the casing from excessive pressures and corrosion attack from produced fluids. It also assists in remedial operations by providing a high pressure

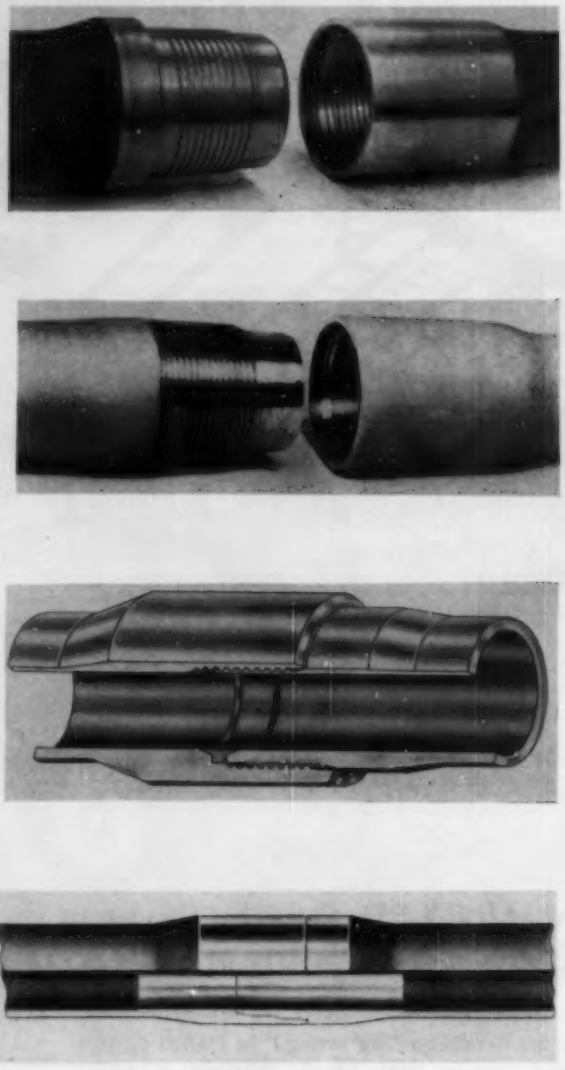


Fig. 6 — Metal to metal sealing type tubing joints used for high pressure applications.

member in which fluids can be pumped to the formation or bottom of the well in killing, fracturing, or cementing operations. Since the tubing aids in improvement of flow conditions and assists in protective measurements, some states and many fields have specific instructions and laws for its usage and placement in the well.

In most cases, the tubing is set near the top of the producing interval to reduce the possibility of its being surrounded by sand or other material from the producing interval that could cause removal troubles. However, it may be run below the producing interval where sand problems are not serious or the well is a low producer on artificial lift. It may also be set 800-1500 ft or more above the producing interval in cases where permanent type completion equipment is used, or where high fluid levels exist. In certain wells having high fluid levels and sand producing

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

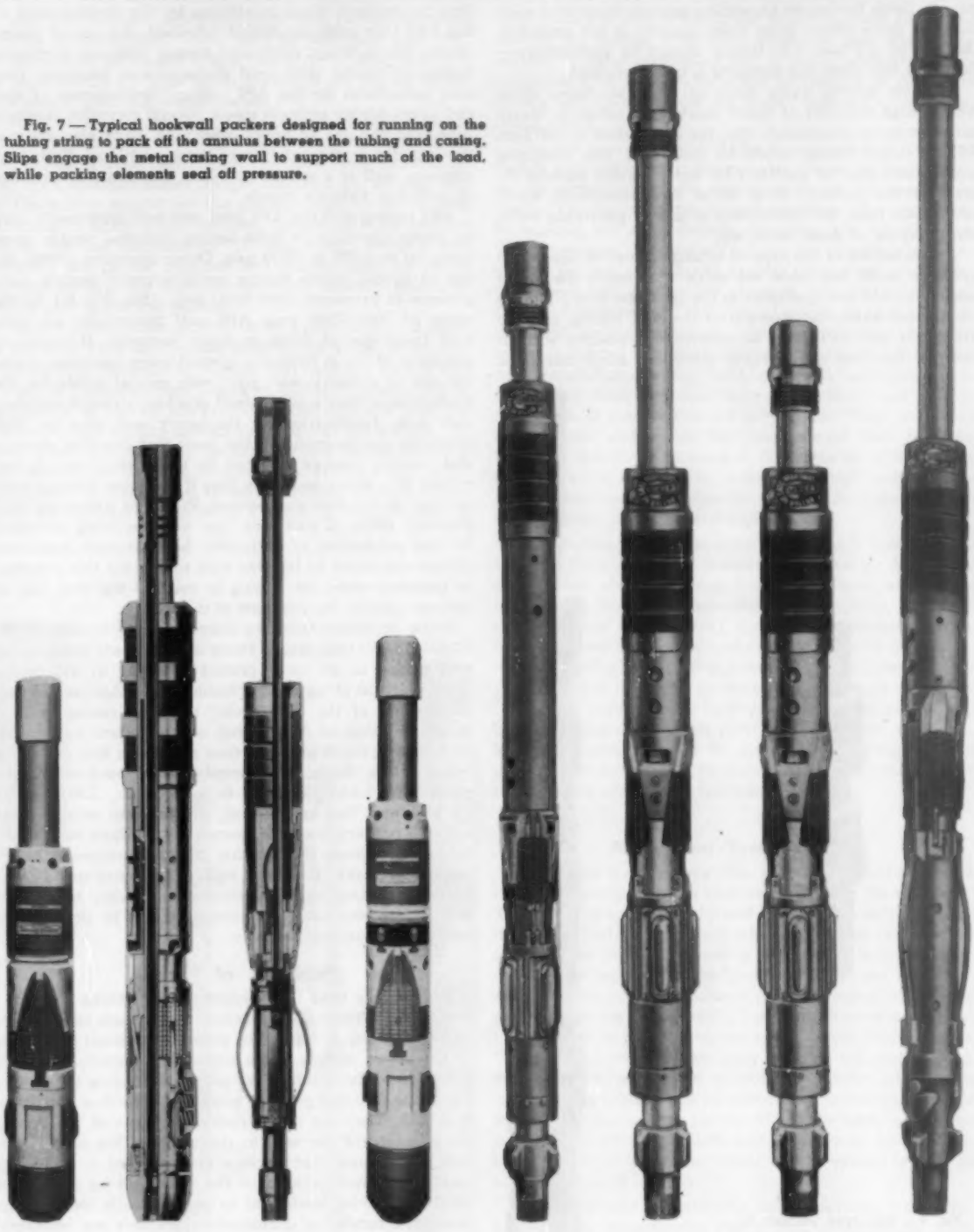


Fig. 7 — Typical hookwall packers designed for running on the tubing string to pack off the annulus between the tubing and casing. Slips engage the metal casing wall to support much of the load, while packing elements seal off pressure.

problems, some measure of sand control may be obtained by setting tubing high. In general, though, it is set 10 to 60 ft above the producing zone on initial completion.

The type of production, probable production rate, and the type of artificial lift, dictate the size of the tubing used. To obtain adequate clearances for remedial operations that may be needed to fish for the tubing, the size of the tubing often dictates the complete casing program of a well. In general, 2.375-in. OD tubing is used with 4.5-in. OD, 5-in. OD, or 5.5-in. OD casing, whereas 2.875-in. OD or 3.50-in. OD tubing is used with 7-in. OD casing. The 2.875-in. OD tubing in 7-in. casing or 2.375-in OD tubing in 5.5-in. OD casing are the most popular sizes used.

Use of 2.375-in. OD tubing generally is satisfactory for gas rate withdrawals of 3-5 million cu ft per day, whereas 2.875-in. OD is satisfactory up to 12-15 million cu ft per

day. In fields having an expanding gas-cap drive or a solution gas drive where large fluid capacity is not expected, the use of 2.375-in. OD tubing should be satisfactory—provided that deep rod pumping is not attempted.

In fields having water drive or a partial water drive where large volumes of water must be handled to obtain satisfactory oil production, then the installation of 2.875-in. OD or larger tubing would be indicated. The foregoing generalities may be qualified by many factors, such as increasing the pressure drop under flow conditions, lower production rates, the availability of gas for gas-lifting wells, the pumping of deep wells, etc.

The selection of the type of tubing for use in deep, high pressure wells has been the subject of much discussion among oil and gas operators in the past few years. Due to the deeper wells, the strength of the API tubing, and the ability of the API joint to withstand pressures without leaking, has had considerable attention. Much has been done to improve these conditions by the development of the API high pressure thread lubricant, the use of power driven tubing tongs, controlled torque make-up, hydraulic testing of tubing after joint make-up and improved running procedures for the API tubing. Development of special joints, higher strength steels, special corrosion resistant pipe, and the use of heavy wall pipe, have also assisted the industry in the solution of these problems. Each high pressure well is a special problem, but some generalities of selection indicate trends.

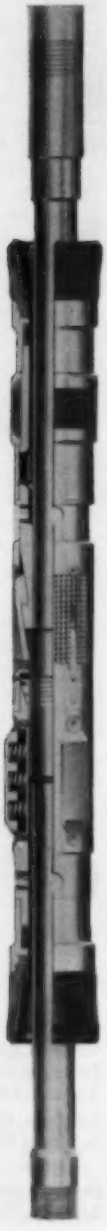


Fig. 8 — Cup type packers for use in permanent and conventional completions. Pressure exerted from below or above causes flexible cups to seal tighter against casing wall.

API tubing with the API joint and wall thickness is used by many operators in wells having potential shut-in pressures up to 6000 to 7000 psig. Other operators prefer the use of special joints having metal-to-metal sealing components at pressures over 5000 psig. (See Fig. 6.) In the range of 5000-7000 psig, API wall thicknesses are used with these special joints in many instances. However, at pressures of about 7000 and upward many operators prefer the use of a heavy wall pipe with special joints for the protection of their wells instead of a high strength standard wall pipe. Justification for the heavy wall pipe for high pressures can be made on the basis that handling damage and running damage incurred by tongs, slips, etc., is less critical in a heavy wall pipe than if the same damage were to occur in the thin wall section. Problems connected with ductility, effect of corrosion, and manufacturing processes for the production of extremely high strength steel also dictate the trend to heavier wall tubing for the extremes in pressure when the tubing is used as the first line of defense against the pressure of the well.

Some departure from the above is made in wells in the 10,000-15,000 psig range. These operators are using heavy wall tubing as an inner protective string to the casing. They seat this string on a drillable production packer near the bottom of the last regular string of casing used. A macaroni string of API tubing, or a standard wall tubing with high strength joints, is then run inside this protective tubing string. Some of the combinations used or contemplated are 4.5-in. OD, 15.2-lb × 2.375-in., 2.875 OD × 1.6 OD, etc. The inner string, or macaroni string, is not set on a packer; therefore, corrosion inhibitors can readily be pumped down the annulus or the macaroni string to prevent corrosion. In case of leaks in the outer string, circulation conditions can be established quickly to kill the well before any extensive damage might be done to the well or surrounding property.

Functions of Packers

Packers are used in conjunction with tubing to form a first line of defense against excessive pressures being placed upon the casing of the well by either operational procedures or conditions of flow in the well and/or internal attack of corrosion to the casing. They aid in prolonging the flowing life of the well and produce more favorable flow conditions in a well. They aid in the control of the well by limiting the pressure of the well to the tubing. This aspect is of such importance that packers are required to be run to maintain a fluid column in the casing-tubing annulus in off-shore flowing wells and in certain wells located near roadways, canals, or communities. Packers are integrated so closely with the completion practices used and the future of the well that a discussion of the various types of packers and their usage is included in any discussion of completion problems.

Packers and Their Uses

A packer is any mechanical device that is used to pack off the annulus between the tubing and casing, tubing and open hole, or in case of drill stem tests, between the drill pipe and casing or open hole. Retrievable packers are classified generally as hook wall packers, anchor packers,

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

or cup type packers, depending upon their construction and setting characteristics. These may be equipped with hold down devices as needed to keep them from being unseated or pumped up the hole when pressures are higher below the packer than above the packer.

Hook wall packers (See Fig. 7) may be set or re-set at any desired point in the hole by manipulating the tubing and releasing slips that engage or "hook" into the wall of the hole. Compressional weight afforded by setting part of the tubing weight on the packer expands the sealing elements to effect a seal between the packer body and the casing. Sealing elements of "O" ring design effect a seal between the packer mandrel and packer body on many packers to form the complete isolation between pressures above and below the packer.

Anchor packers can only be set at a predetermined point in the hole. They too depend upon tubing weight to expand their sealing elements to effect a seal between packer and casing. A predetermined length of tubing is placed below the packer to contact the bottom of the hole and hold the compressional weight needed to compress the packer. To keep from damaging the packer element before reaching the bottom of the hole, a shear pin arrangement is incorporated in the packer. When the tubing or anchor contacts the bottom of the hole, a force of 6000-10,000 lb shears this pin, thus allowing the packer element to expand against the casing. This type of packer was one of the earliest designs attempted but is more widely used in formation type packers for either production or drill stem testing activities than for the higher pressure completions inside casing today.

The cup type packer (See Fig. 8) is a pressure energized packer not requiring compressional forces to keep it set. As the name implies, its sealing elements are cup-like in design, i.e., having general characteristics of a swab cup. In running, the cups contact the casing wall at all times. When pressure differentials occur, the pressure tends to expand the cup more firmly against the casing, thus effecting a seal; the greater the pressure, the better the seal. Various adaptations of this type of packer are used in conventional well completions, permanent type completion work, as special type packers used to isolate casing leaks, well completion cleaning techniques, and fracturing operations. They have been used very satisfactorily under many conditions of completion and production. Their simplicity of operation and design has been one of their features. However, due to the thinness of the rubber at critical points they are more susceptible to failure at high temperatures and pressure conditions than are many of the compressional type packers or permanent type packers.

Hold downs may be used with retrievable type packers to keep them seated if pressures are greater below the packer than above it. These hold downs may be mechanically or hydraulically operated. The majority in use at this time are of the latter type. When pressure in the tubing is greater than the hydraulic pressure in the casing-tubing annulus, the tubing pressure acts on pistons that are directly or indirectly connected to buttons, or slips, that contact the casing. These hold the tubing in the packer and keep the packer in its set position. These aids to the retrievable packer increase its versatility of application and give it some features of the permanent type packers, while retaining its removable features.

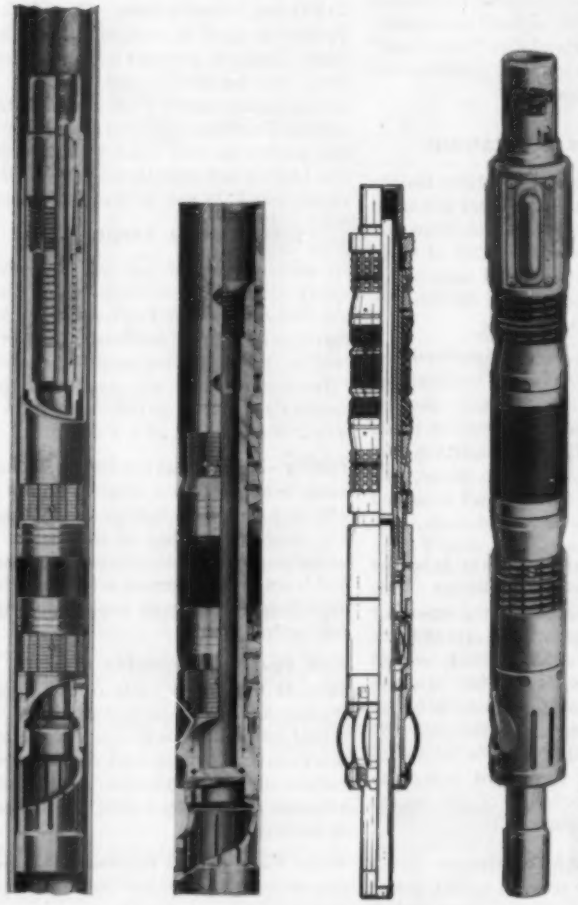


Fig. 8 — Permanent or drillable type production packers. Body of these packers is removed from the casing by conventional drilling.

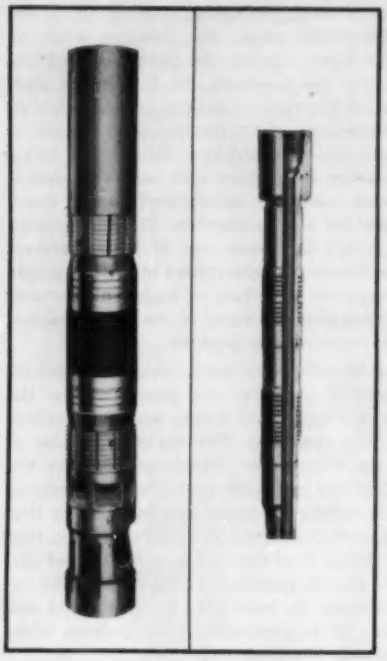
Permanent Type Packers

Permanent type packers (See Fig. 9) are not retrievable but must be drilled up to remove them from the well bore. They may be set at any desired point in the well, but once the packer body is set it cannot be moved. The tubing, however, can be pulled or re-set in the packer body as many times as is required if the packer body is not damaged. After the body of the packer is set, a sealing element is made up on the tubing string, and this element is stabbed into the packer by running the tubing to the proper depth. The element seals in the inner bore of the packer. The tubing may be held in the packer by a locator sub and the weight of the tubing or by a latching mechanism that latches to the main body of the packer. When the latch is used the packer will hold high differential pressures from either above or below. Also, the tubing can be placed in tension at the packer, if desired.

Since this type of packer is not retrievable, many features can be incorporated into it that would not be satisfactory in the design of a retrievable type packer. The slips are an opposing type and very rugged; both lead and rubber can be used for sealing elements. The packer is therefore very adaptable for high pressure, high temperature installations. As the sealing element has less OD than a conventional retrievable packer, tubing pulling operations tend to be simplified in many instances. Many operators prefer to take less risk on pulling the tubing and a relatively known cost of drilling up a drillable type packer to the possible higher cost of removing other packers should they stick in the well.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

"Universal" Aptly Describes Range of Applications of BAKER Retainer Production Packer



Baker Retainer Production Packer
Product No. 415-D

Baker Locator Tubing Seal Assembly
Product No. 442-E2

ADVANTAGES of the Baker Retainer Production Packer:

1. *Forms positive, leak-proof pack-off against any pressure differential from either above or below the packer that is safe for the casing.*

2. *Pack-off achieved without excessive set-down tubing weight, or tubing in tension.*

3. *Permits tubing string to be anchored to the packer, released from the packer, or completely removed from the packer, all at the discretion of the operator.*

4. *Complete removal of the tubing string from the packer will not disturb the isolation of the zone below the packer, provided the pressure differential is from below the packer.*

5. *Pack-off remains leak-proof under conditions of high temperature, even under pressure differentials that exceed the safety limits of the casing.*

6. *Can be set on wire line, tubing or drill pipe.*

In practically every production application the Baker Retainer Production Packer has earned the designation "Universal" Type; and it appears also to be the answer to many future production problems.

The range of applications is further broadened by its ability to hold high pressures from above or below—at record or shallow depths—even under temperatures in excess of 300 degrees Fahrenheit.

Because it can also be used successfully as a squeeze tool, it is ideal for testing, acidizing, formation fracturing, squeeze cementing, and other operations required in the completion or work-over phases of a well.

The following actual field records of general production, as well as supplemental applications of this "Universal" Type Packer may indicate a solution to your well problems:

PRODUCTION APPLICATIONS

Single-Zone Production—More Baker Retainer Production Packers are used for single-zone production than for any other application—proof of their increasing and widespread usage in a field previously dominated by retrievable type packers.

Dual-Zone, Single-Packer Application—The majority of dual-zone applications of the Baker Packer are single-packer, dual-zone installations. Because of its remarkable ability to maintain the absolute separation of two zones, this packer is widely known and accepted as the ideal dual-zone packer.

Dual-Zone Production (Baker Selective Hook-Up), Two-Packer Installation—This efficient hook-up enables the operator to produce (pump or flow), treat (formation fracture, acidize, etc.), or test either zone selectively through the tubing, while simultaneously producing the remaining zone through the annulus. The switch in flow, or selection of a zone for treatment, is accomplished at the discretion of the operator, using an instrument line.

Permanent-Type Well Completions—Long recognized as the world's most permanent production packer, the Baker Retainer Production Packer was accepted early in the development of this new completion idea as OUTSTANDINGLY FIRST for Permanent-Type Well Completions.

Parallel Tubing Installations—When a *single* packer is used, each tubing string can be run or pulled independently of the other, and by using a special Anchor and a Latching Sub, the short string can readily be anchored to the long string.

When *two* packers are used, each string is run or pulled separately, however, the long string must be *run* first, and the short string *pulled* first. Either the single-packer or the two-packer installation features a full opening to the lower zone for use of all permanent completion-type tools.

Off-Shore Installations—The Baker Packer is used in conjunction with a storm choke to prevent loss of production due to accidental damage to surface connections of off-shore installations. Permanence, plus the ability of the packer to hold mud weight above the packer are additional factors that recommend its use in this application.

SUPPLEMENTAL APPLICATIONS

In addition to its use in practically every type of production application, the Baker Retainer Production Packer can also be used effectively as a squeeze tool in the following wide variety of "Supplemental" applications that might be required in the completion or work-over phases of a well:

Testing—As many as ten Baker Packers have been used in a single well for an efficient, complete bottom-to-top testing program. Ability of the packer to withstand reverse in pressure differential from high-pressure acid squeeze to swabbing enhances its use as a successful testing tool.

Acid Squeeze, Formation Fracture, or Squeeze Cementing—Use of the Baker Packer as a squeeze tool in either the initial completion or during subsequent work-over is widespread, due to elimination of the unnecessary additional expense of running a separate squeeze or testing tool.

Water Flood or Gas Injection—The permanence of the Baker Retainer Production Packer, plus the advantage of a free tubing string, make it a superior packer for secondary recovery instal-

lations. The packer has also been used in dual-zone wells where one zone is produced, with simultaneous injection into the other.

Isolation of Annulus—The Baker Packer is corrosion resistant. This feature, plus the fact that the packer permits removal of the production string without disturbing the isolation of the zone below the packer (pressure differential must be from *below* the packer) make it an ideal packer for use in corrosive areas where protection of the casing above the producing zone is of great importance.

Bridge Plug, Temporary or Permanent—The Baker Packer acts as a one-way bridge plug whenever the tubing is removed from the well, provided the pressure differential is from below the packer. It can easily be converted to a temporary two-way casing bridge plug or a permanent bridge plug.

POPULAR APPLICATIONS OF: the Baker "Universal" Type Retainer Production Packer

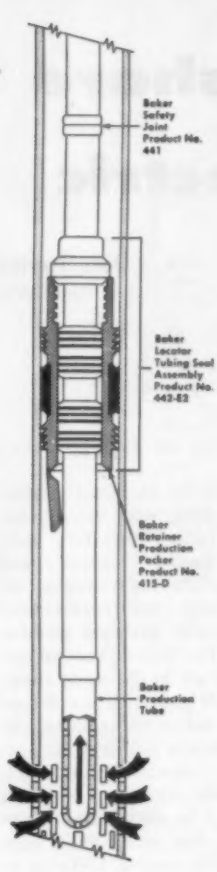

Baker Safety Joint Product No. 441
Baker Locator Tubing Seal Assembly Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Production Tube

Fig. 1

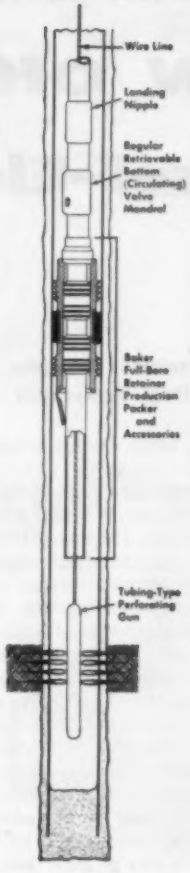

Wire Line
Landing Nipple
Regular Retrievable Bottom (Circulating) Valve Mandrel
Baker Full-Bore Retainer Production Packer and Accessories
Tubing-Type Perforating Gun

Fig. 2

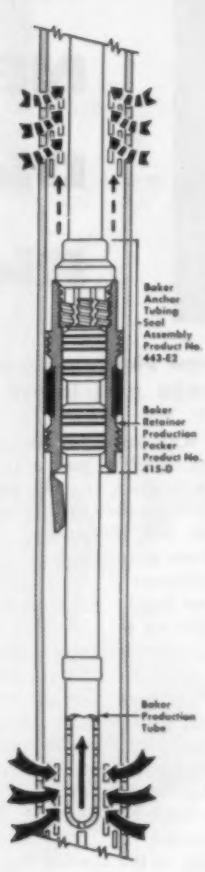

Baker Anchor Tubing Seal Assembly Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Production Tube

Fig. 3

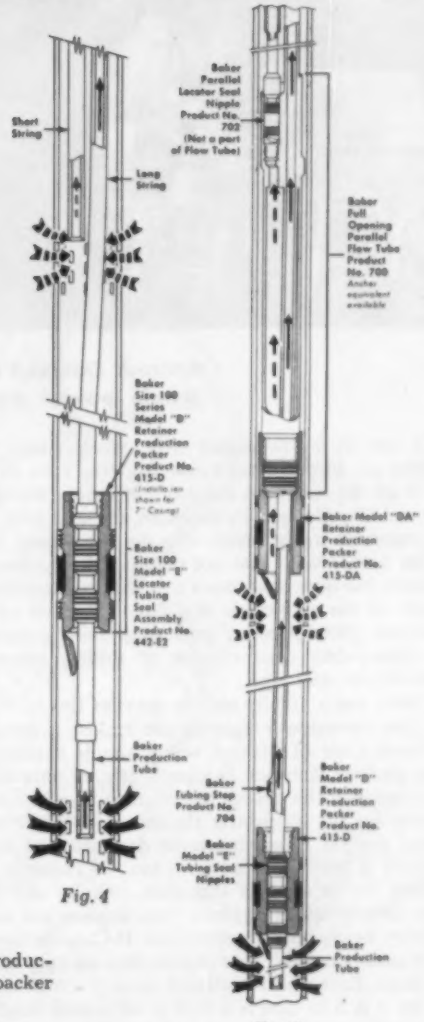

Short String
Long String
Baker Parallel Locator Seal Nipple Product No. 702 (Not a part of Flow Tube)
Baker Full Opening Parallel Flow Tube Product No. 700
Baker Size 100 Series Model "D" Retainer Production Packer Product No. 415-D
Baker Size 100 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Production Tube
Baker Tubing Stop Product No. 704
Baker Model "E" Tubing Seal Nipples
Baker Model "DA" Retainer Production Packer Product No. 413-DA
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Production Tube

Fig. 4

Fig. 5

SINGLE-ZONE Fig. 1.—Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single-zone production.

PERMANENT-TYPE WELL COMPLETION Fig. 2—Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the packer.

DUAL-ZONE, SINGLE PACKER Fig. 3—Illustrates Packer set in casing with anchored production string for dual-zone production. Tubing can be released from packer by rotating to right.

DUAL-ZONE, PARALLEL STRINGS, SINGLE PACKER Fig. 4—Illustrates the simplest form of parallel string installation. A variation permits anchoring short string to long string, if desired. Note full opening to lower zone for use of all permanent completion-type tools.

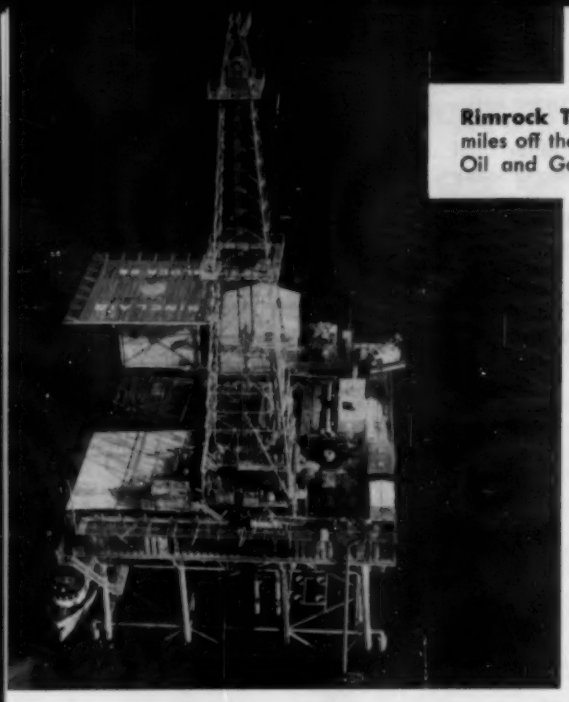
DUAL-ZONE, PARALLEL STRINGS, TWO PACKERS Fig. 5—Illustrates two-packer parallel string installation with each zone confined to its individual tubing string, with full opening to lower zone for use of all permanent completion-type tools.

How to get complete information...

A new 72-page catalog supplement is now available on the Baker Retainer Production Packer and its many features and applications. Address any office, or ask your Baker representative for Baker Catalog Supplement No. 502.

BAKER OIL TOOLS, INC.

HOUSTON • LOS ANGELES • NEW YORK



Rimrock Tideland's new platform rig starts its first job 20 miles off the coast of LaFourche Parish, Louisiana. It is on Sinclair Oil and Gas Company's Block 86 in the South Timbalier area.

Horsepower "Eggs" in Many Baskets On...

NEW Offshore Diesel-Electric Rig

Don Taylor
Gulf Coast Editor

Rimrock Tideland's new platform rig incorporates flexible, simple power package plus latest drilling equipment.

As you fly by helicopter from Morgan City to Rimrock Tidelands, Incorporated's new Rig No. 3 on its first job 20 miles off the Louisiana coast of LaFourche Parish in Sinclair Oil and Gas Company's Block 86, the structure, derrick and rig resemble many others that dot the watery Gulf. But, a closer look reveals that not only is it brand new from stem to stern, but it incorporates a new idea in diesel-electric power. Heart of the all-electric Rig No. 3 consists of two highly compact 1000-hp power generating units, putting this rig in the heavy-duty class capable of drilling below 15,000 ft with 4½-in. drill pipe.

"Why use a 100-hp unit to develop 100 hp?" "Why have all your horsepower 'eggs' in one basket... especially in the offshore Gulf of Mexico where simple engine repairs can take weeks?" Rimrock Tidelands, Inc., of Shreveport, Louisiana, supplied the answer in designing its offshore Rig No. 3. Power for the all-electric rig comes from the two 1000-hp diesel electric generating units designed and fabricated by Stewart & Stevenson Services, Inc., of Houston. Key to the answer lies in the fact that each 1000-hp unit is driven by four 250-hp diesel engines. Two engines are tied into one 600-hp heavy-duty traction-type D.C. generator, with two such generators and four engines making up a single 1000-hp package. Each unit is mounted on a skid measuring 24 ft 10 in. by 7 ft 6 in. and is 6 ft 6 in. in overall height. The four diesel engines face outward and drive the center mounted generator through disconnect clutches and flexible couplings which take care of any possible misalignment. Thus, the operator can shut down any single engine and maintain the generator in service at reduced horsepower.

So far as handling is concerned, the units have about the same dimensions and weight as a single 1000-hp diesel electric generator set. Yet, the developed electrical power can come from one, two, three or all four of the 250-hp engines mounted tail-to-tail in pairs on each end of the 600-hp direct current generators.

In the event engine repairs are necessary, any one of the 250-hp diesel engines can be changed in a matter of an hour or so. And, to make certain that there is always an engine available, Rimrock has a standby lighting generator set powered by a similar 250-hp diesel engine that can be substituted for the engine taken out of service on the 1000-hp power package.

The power package. Each of the 600-hp electrical generators operate between 900 and 1000 rpm, with the engines turning at between 1584 and 1760 rpm. Here's how each engine is synchronized: Each engine runs at constant speed with individual vernier throttle controls for changing or varying the speed when required. An individual thermometer in the combined exhaust of each engine provides positive means for checking synchronization. The vernier control can be adjusted until the engine exhausts are in the same range on the thermometers. Blowers on each generator are driven through a shaft which is direct connected to the exciter shaft.

Motors. The Brewster N-12 drawworks is driven by two 650-hp heavy-duty traction type direct current motors. Each motor is driven by a separate generator, through a common control. These motors are cooled by 2-hp electrically driven blowers. A fixed center type 1½ by 4-in. roller chain connects the drawworks to each motor, providing 1200 hp to the drawworks.

Controls. To simplify controls, each of the electric motors on the drawworks and mud pumps is wired so that there is never more than one motor being powered by a single generator. This arrangement permits the use of a simple low-voltage rheostat control to a pilot exciter for each generator which controls the speed of the electric motors. This simplicity of controls enables rig personnel without specific training to understand the system.

The driller's controls consist of a clutch and throttle, which are one and the same. The driller can operate the pumps, drawworks, etc., from a simple console.

The platform. The platform, designed and constructed by J. Ray McDermott of Harvey, Louisiana, contains crew quarters and recreational facilities for 40 men. It is equipped with a heliport on top of the crew quarters. Around the outside of the platform are mud storage bins, fuel, water and chemical storage. The platform is served by two 86-ft crew boats and a 114-ft cargo vessel in addition to helicopters.

The following illustrations take the reader on a tour of the new diesel-electric rig for a closer look at the component parts.

BAASH-ROSS HINGED CASING SPIDER

simplifies any casing operation

Lightweight —yet ample strength for longest and heaviest casing strings!

- Can be placed on cribbing . . . or on rotary table . . . or in place of it.
- Handles any casing operation and is ideal for running wash-over strings.
- Interchangeable bushings provide wide choice of slips . . . rotary slips . . . "UC" Slips . . . and others.
- Remove one or both pins for easy installation . . . easy handling . . . convenient transportation.

BAASH-ROSS TOOL COMPANY

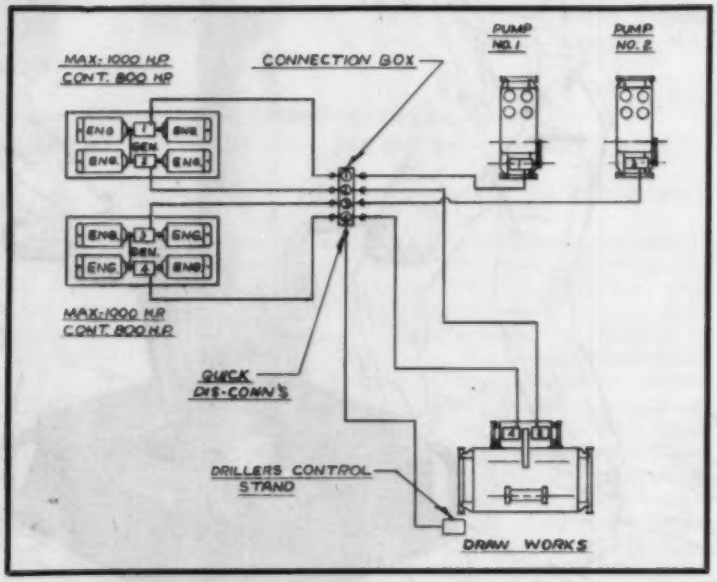
DIVISION OF JOY MANUFACTURING COMPANY

Los Angeles, Calif. • Houston, Texas • Odessa, Texas • Oklahoma City, Okla. • Casper, Wyo. • Olney, Ill. • Edmonton, Alb., Canada • New York City

Rimrock Tideland's officials watch operation of new rig over shoulder of driller Jimmy Daniel, right. Left to right are: G. D. Murray, vice president; William C. Kneale, president; and Marvin Ellis, tool pusher.

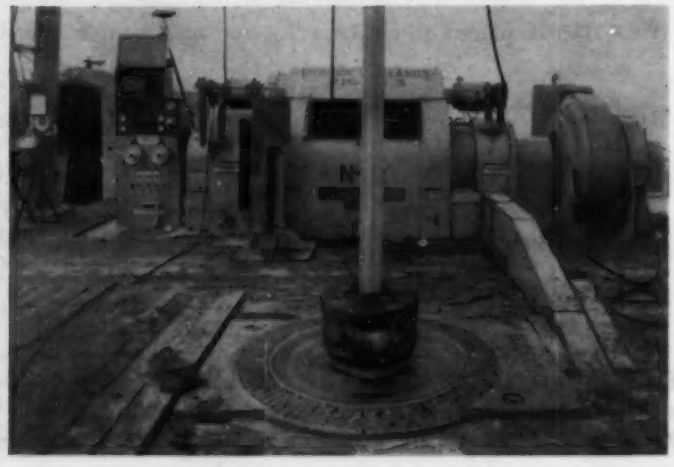
Innovation in rig electric power are these two 1000-hp skid-mounted diesel-electric generator sets. Engines are 250-hp mounted tail-to-tail, each pair drives a 600-hp traction-type generator.

Electrical flow diagram shows simplicity of system. Note that each motor is powered by one generator, and that controls can transfer the electrical load.



Behind drawworks are two 650-hp D.C. electric motors. One generator drives one motor, thus simplifying the controls which are rheostats on the pilot exciter of each generator.

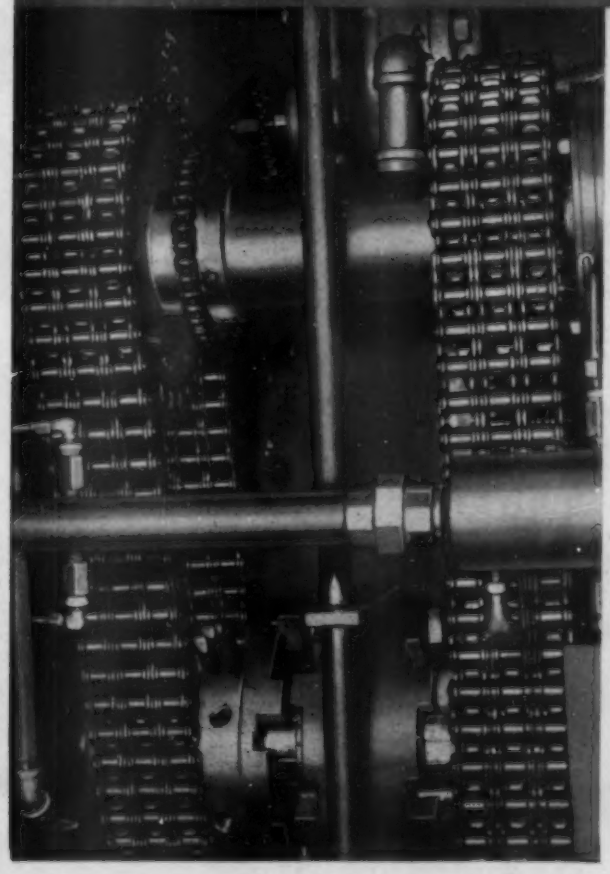
On automatic pilot, drilling goes ahead. No one is at drawworks controls, but rotary table is turning at set speed with auto feed off unit controlling bit weight. Left panel includes all driller's controls.



DIAMOND
Roller Chains
As Usual on the latest advancements in Rig design and manufacture

Cardwell New J-450 and S-350

FOR LONG-LIFE DEPENDABILITY



As rig builders strive to provide new and better rigs to meet today's drilling problems, time-tested Diamond Roller Chains continue to serve. Rig manufacturers and users realize the importance of making hole faster by eliminating all chances of unnecessary delays.

Diamond Roller Chains have proven their long-life dependability of performance through all the years that modern rigs have been made . . . Every foot is preloaded before shipping.

The "Diamond" trade mark on the Chains used is a good sign of quality and modern rig design.

SHOT-PEENING SINCE 1944 Diamond Chain has long recognized that certain types of internal stressing of chain parts would increase fatigue resistance. To this end, link plates have been specially processed and chain rollers and other parts have been shot-peened since 1944.

DIAMOND CHAIN COMPANY, Inc.

Where High Quality is Traditional

Dept. 441 402 Kentucky Ave., Indianapolis 7, Ind.

Tulsa Office: 2238 Terwilleger Blvd.

Offices and Distributors in All Principal Cities

Please refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER.

Reed Announces

In

Research and engineering development maintain

Write or wire for complete information... or have your nearby Reed man explain the economic advantages of Inarcled hard faced tool joints.

arclad®

Pronounced "Inner Clad"

Reed's advanced hard metal application for Tool Joints...

Inarclad utilizes Reedite hard metal to protect tool joints as do Reed's two other methods (Surface Concentration and Deep Penetration) . . . but . . . Inarclad differs in the process used in that Inarclad welds the hard metal into the tool joint steel rather than binding the hard metal onto the surface of the tool joint.

The application of the hard metal with the new method is done by an automatic electric welding machine utilizing an inert arc process. Using a non-consumable electrode, an electric arc melts the tool joint steel into a puddle at the proper spot. Hard metal grains are fed into the puddle automatically. The arc is shielded by a continuous flow of inert gas to prevent contamination or oxidation of the steel during the melting process.

ADVANTAGES

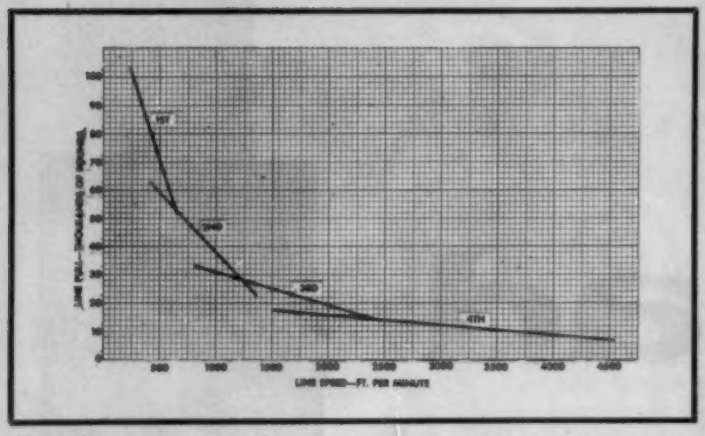
1. **Inarclad uses the high alloy steel of the tool joint itself as the binder for the hard metal. Reduces chances of spalling or flaking!**
2. **The steel of the tool joint will not become oxidized by the heat of the weld because the arc is operating in an inert atmosphere.**
3. **The weld is made by an automatic machine which eliminates human errors. Superior weld quality!**
4. **Reedite is fed into the weld by machine, thus giving a better distribution of hard metal throughout the band. Uniform, measured amount of hard metal is put into each band!**
5. **The hard metal is distributed uniformly in depth through the band. This assures that a uniform number of hard metal grains are always resisting abrasive wear until the hard metal is worn completely away. Uniform wear rates!**
6. **The hard metal bands have a concentration of hard metal approaching that of Surface Concentration method and equal the depth of Deep Penetration method. More hard metal!**
7. **The hard metal is applied to the tool joint without recessing and results in a slight surface build up. This build up equals approximately 1/32 in., which increases the tool joint O.D. about 1/16 in. The O.D. of the tool joint remaining after all the hard metal has worn away is 1/16 in. larger than it would be if the same bands had been laid in recesses.**

Unretouched photo of Inarclad cross section sample.

REED **leadership in tool joint design.**

THE MARK OF QUALITY

REED ROLLER BIT COMPANY, HOUSTON 1, TEXAS NEW YORK LONDON BUENOS AIRES

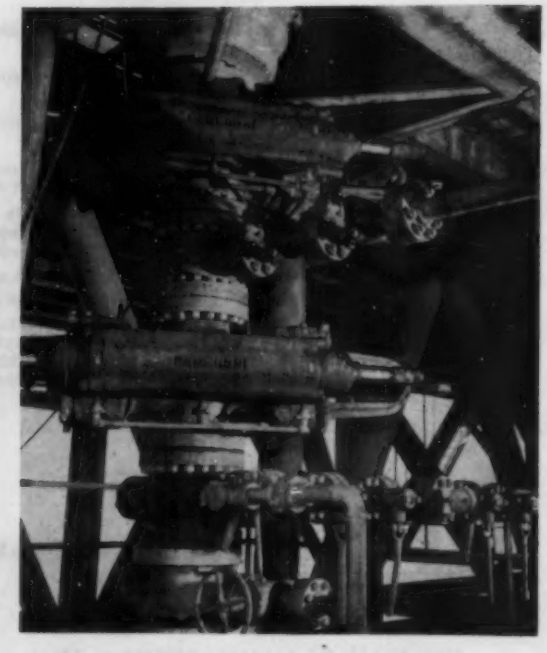


Drawworks line speed curve in each gear for various line loads.

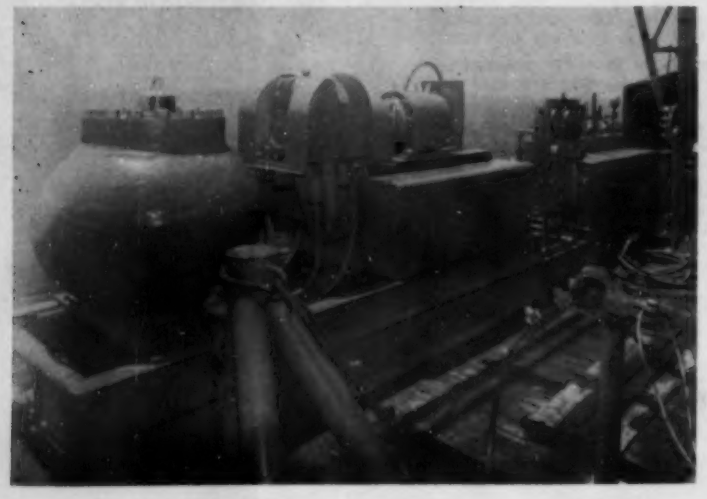
Travelling block, hook and swivel. The block has a 500-ton capacity; the hook, 450-ton.

Rig has three mud pumps. Two are electrically powered; one is powered by a diesel engine. Pump at left is 7¾-in. by 18-in. and is powered by two 625-hp electric motors; middle pump is 7¾-in. by 16-in. and powered by one 625-hp motor. Both pumps are fully controlled by the driller.

Blowout preventer hookup beneath the floor of Rig No. 3 includes two hi-pressure ram type units and one packer type preventer at top.

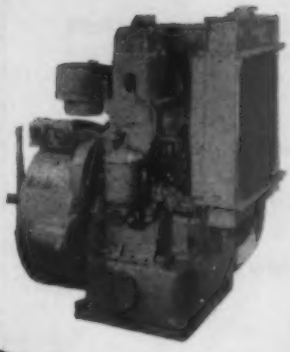


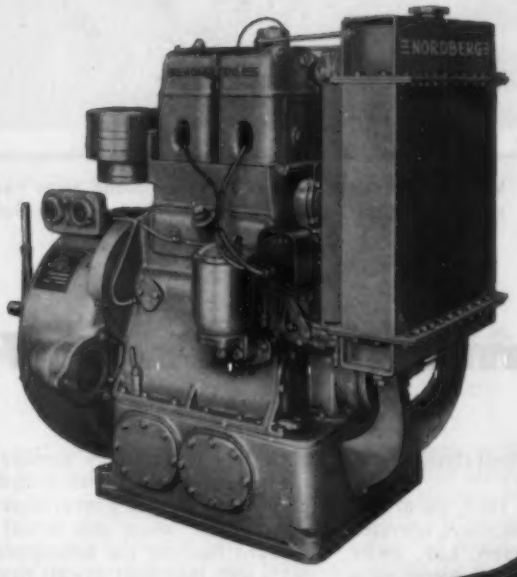
Heart of blowout protection is this large accumulator which holds a reserve of fluid under pressure to actuate the blowout preventers. It is equipped with a 10-hp electric pump.



NORDBERG POWER CHIEF
OILFIELD PUMPING ENGINES

...now available in SINGLE-CYLINDER...





and TWO-CYLINDER sizes ranging to 36 horsepower

Meeting the demand for increased horsepower to facilitate handling, a wider range of production pumping and other oil field power jobs, NORDBERG now presents its *new* two-cylinder *POWER CHIEF* Gas Engine, rated to 36 H.P. maximum.

The new two-cylinder model embodies all the proved advantages of the single-cylinder *POWER CHIEF* Gas Engine. It can be supplied with straight gas or combination gas-gasoline carburetors and is furnished with enclosed clutch power take-off and safety shutdown control as part of standard equipment.

For complete specifications see your nearest Nordberg Distributor, or clip and mail the coupon today.

NORDBERG MFG. CO., Milwaukee, Wisconsin

BULLETIN 242 gives complete specifications and data covering the new Nordberg TWO-CYLINDER *POWER CHIEF* GAS ENGINE. Check coupon for your copy.

BULLETIN 231A gives complete specifications and data covering the Nordberg SINGLE-CYLINDER *POWER CHIEF* GAS ENGINE. Check coupon for your copy.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

Available at your local Nordberg Store or contact these Authorized Distributors:

SOUTHERN ILLINOIS—Stephens Oil Field Repair, Fairfield, Ill.
KANSAS—Mead Engine & Welding Works, Sterling, Kans.
OKLAHOMA—Cooperative Engine Maintenance Co., Inc., Seminole, Okla.
HOUSTON & GULF COAST—Diesel Engine & Equip. Service Co., Houston, Tex.
LOUISIANA & MISSISSIPPI—Nugent Diesel Engineering Co., New Orleans, La.
WILLISTON—Tractor & Equip. Co., Sidney, Mont.
COLORADO—FULLERTON—Mead Engine & Welding Works, Sterling, Colo.

MAIL THIS COUPON PN

Nordberg Mfg. Co., Milwaukee 1, Wis.

Please send ☐ Two-Cylinder Bulletin 242.
☐ One-Cylinder Bulletin 231A.

Name_____

Company_____

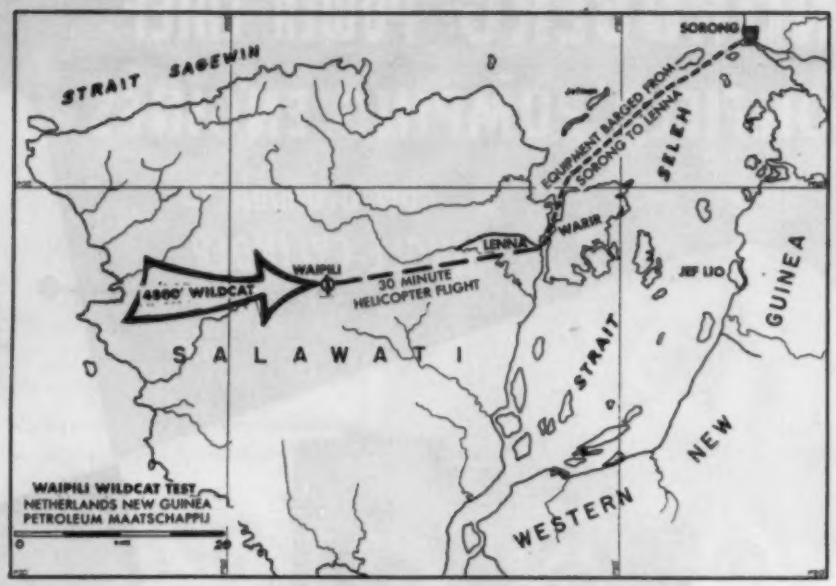
Address_____

City_____ Zone____ State_____

© 1956, Nordberg Mfg. Co.

4-356-0

In 40 days, complete rotary rig, supplies, materials, a camp and men flown by helicopter to New Guinea well site.



Waipili wildcat located 15 miles inland from nearest supply point on Salawati island in Western New Guinea.

Operation Airlift . . .

240 Tons Equipment Flown To

THE first exploratory drilling venture in the world where a complete rotary rig, camp, men, supplies and materials were flown into the jungle location and maintained entirely by the whirlybirds was a wildcat in the swamps of Salawati Island in West New Guinea. Drilled by Netherlands New Guinea Petroleum Company (NNGPM) in which Standard-Vacuum Oil Company and Shell each have a 40 per cent interest, with Caltex carrying the remaining 20 per cent, the wildcat test was drilled to 4800 ft but was a dry hole. All equipment and supplies flown in completely by helicopter were flown out again. Although the test was a dry hole, the idea of flying equipment in and out by air was considered a success, and points the way for other similar feats.

Searching for oil in the depths of Salawati's rain forest was rough enough. To set up a drilling camp in the Waipili area (see map), using traditional methods, would have been impracticable. The site was 15 miles from the Strait of Seleh, which separates the island from the New Guinea mainland, and 30 miles from Sorong, the only settlement of any size in Western New Guinea. To construct a road this far inland across Salawati's bottomless swamps would have been excessively costly and would have required a year in the making, plus about three months to drag in equipment.

On September 25, 1955, the first of two S-55 Westland-Sikorskys, operated by Bahamas Helicopters, Ltd., under contract to NNGPM, chattered to a landing on the Waipili site, a small area cleared in the jungle.

By the latter part of October the drilling rig climbed above the treetops. Huts and supply sheds took form, and all the complex equipment required for a major drilling operation was gradually assembled. By November 4 the Waipili wildcat was officially spudded in.

The helicopters not only brought in the steel derrick section by section, but actually helped erect it. Hovering over the structure, the helicopters positioned girders and legs, and later functioned generally as sky hooks for other operations.

Drilling equipment used in this operation was a Brewster type N-2. Three Gardner-Denver mud pumps were used, and all prime movers were General Motors 98 hp diesel engines.

Materials for the site were crated and assembled at the main depot on the New Guinea mainland. From there, barges made a two-hour trip across the Strait of Seleh to a landing dock at Lenna, on the Salawati shore. Each piece was classified by number and category, and tagged with its order of priority in the rigging-up process.

At Lenna, which also served as a forward base for the helicopters, the S-55s took their load directly from the barges, most of the time not even setting down. Prior to departure Lenna radioed Waipili what shipment was on the way, giving the classification and weight of the materials so that the ground crew at the drilling site would be prepared for the arrival of each unit.

The round trip from Lenna to Waipili averaged 30 minutes. Carrying a maximum load of 1375 pounds, the whirly birds made the 15-mile flight at a minimum altitude of 5000 ft. The relatively high flying was required to insure that at all times the planes were within sight of at least two emergency landing spots that had been chopped out of the jungle every quarter of a mile.

Delivery of supplies and equipment to the drilling site was speeded up by suspending loads beneath the planes from a steel sling rather than carrying them in the cabins.

Sections of the rig, the mud pump, a small lighting plant, stoves, refrigerators, beds, crates of food, water bottles — everything destined for Waipili — were attached to the craft by a hook

Landing site at wildcat well on Salawati island. Helicopter unloads supplies on wooden landing ramp. Rig being erected in background.

Ground crew hooks on another load beneath the whirlybird making it easier and quicker to load and unload the heavy cargo.

Jungle Wildcat

with both an electric and hydraulic release fixture. In an emergency (it happened only once) this device enabled the pilot to jettison his cargo with dispatch and gain altitude in time to avoid a thumping encounter with the jungle.

Arriving at Waipili, the S-55s again hovered most of the time while the loads were detached from the carrying hook. Then, often in less than a minute, the rotating birds whirled aloft again on their way back to Lenna for another cargo. This service was fast. But the Waipili ground crew kept pace with it.

Maintaining the shuttle every day, with no night flying, some 201 tons of equipment and supplies were flown into the area before the well could be spudded in. Altogether, a grand total of 240 tons was flown in to maintain the well throughout the drilling period. It took 364 flights—190 hours of flying time—to do the job.

Six months later drilling had produced nothing but an extremely arid hole.

So Bahamas Helicopters, Ltd., originally contracted to take the entire business out of Waipili as well as bringing it in, flew all the equipment back to Sorong. This just about doubled the flying time noted above.

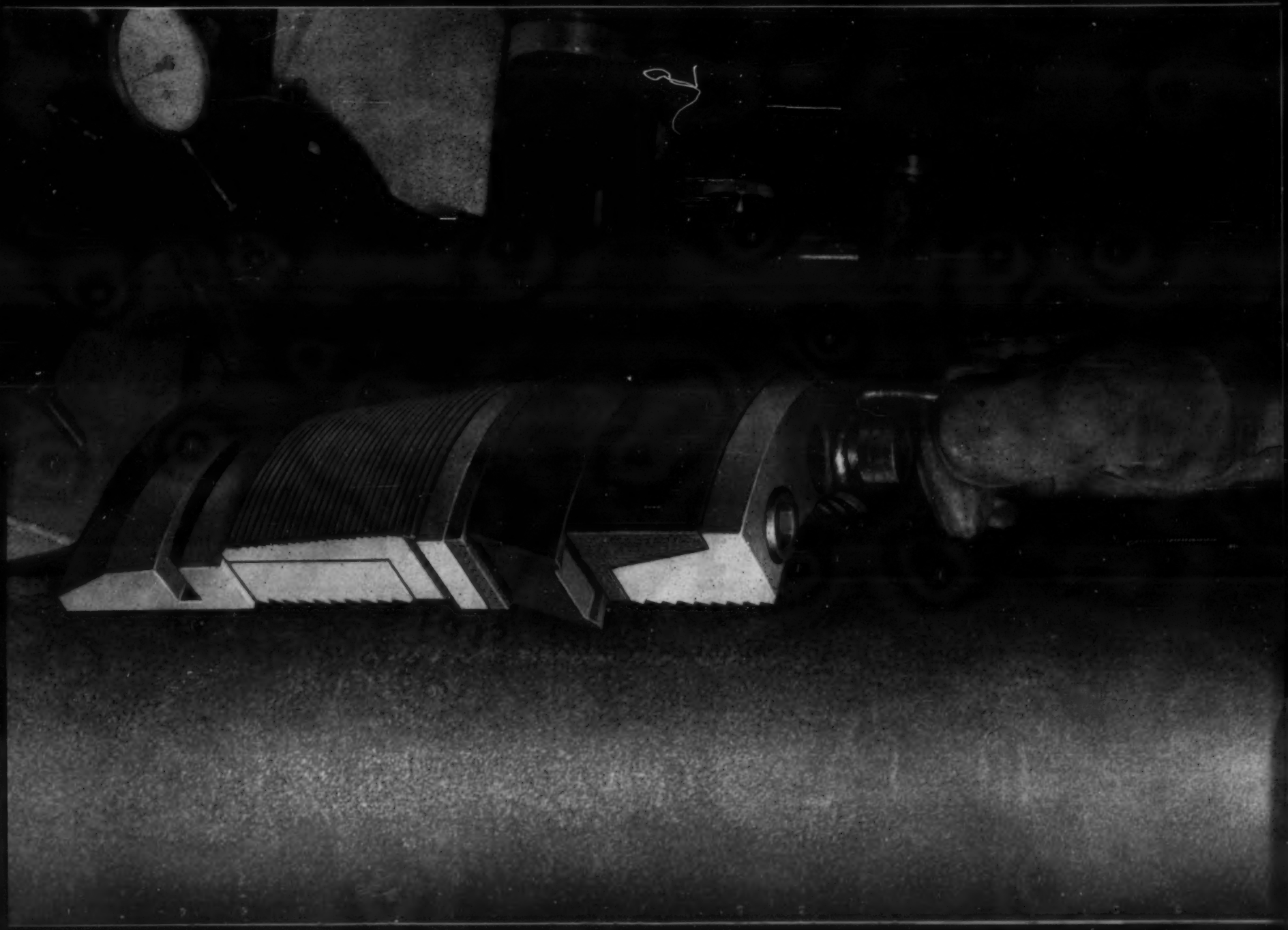
Today there is nothing to show for this daring attempt for oil except a few open spots in the jungle, the clearing where the camp and rig were erected. And by now most of it is probably partly overgrown with tropical vegetation; the jungle moves in fast in that part of the world.

What is the net result of this exploratory adventure in a previously inaccessible and stubborn area?

There is a dry hole, which cost a great deal of money. There is the time, effort and expense of a number of expert geologists, geophysicists, tool pushers, drillers, roustabouts and local laborers. There is the cost of the helicopter service, coming and going. The equipment tab is also added. All this is on the debit side.

But there were great gains. It was proved that such an operation could be successfully carried out. ★ ★ ★

Landing platform at makeshift hanger at Lenna on the coast of Salawati. Helicopters took their cargo directly from barges docked beyond houseboat anchored in background.



Hold Everything!

Heavy casing loads . . . light casing loads . . . low pressures or high, and any loads and pressures in between. It holds everything! That's the new Cameron "CA" Casing Hanger. It's altogether different from any other casing suspension and seal.

The "CA" Hanger is interchangeable in all regular Cameron casing heads. It is fully automatic in operation and can handle pipe loads to joint strength without damage to the pipe. On the other hand, its self-energizing resilient seal is so efficient that it effectively and automatically seals off highest pressures even though the casing load may be extremely low.

Design work on the Cameron "CA" Casing Hanger started years ago. Scores of experimental hangers were produced and put through the most destructive and thorough laboratory and field tests imaginable. Each contributed something to the final "CA" design . . . the ultimate in a safe, flexible, universal casing hanger. Now, regardless of size, weight, and grade of pipe, it can be safely suspended and sealed with a Cameron "CA".

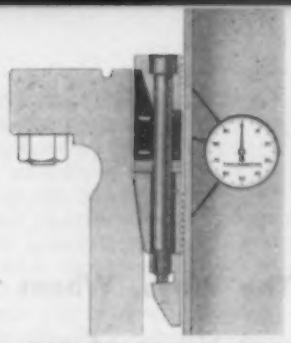
Hold everything . . . until you have inspected this truly remarkable casing hanger. Better still, order one now for your next casing string.

Cameron

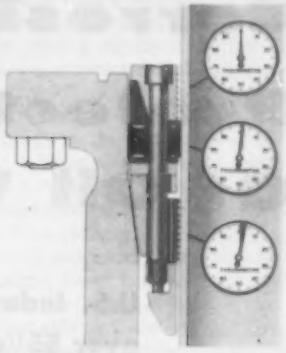
IRON WORKS, INC.

P. O. Box 1212—Houston, Texas

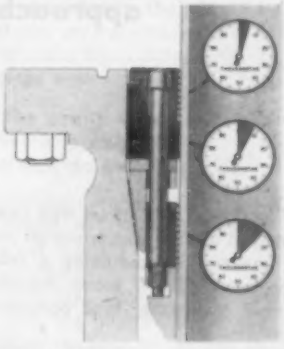
Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works Ltd., Time & Life Bldg., New Bond Street, London W. 1 England.



● **INITIAL CONTACT — NO PIPE LOAD** — Segmented floating bowl will not set prematurely, but provides instant gripping upon contacting the taper in the casing head.



● **LIGHT PIPE LOAD, YET SEAL IS EFFECTED** — Under a few thousand pounds pipe load and with only lower slip segments engaged, self-energizing resilient seal effects pressure-tight packoff. Note only slight deflection in pipe.



● **MAXIMUM PIPE LOAD — MINIMUM DEFLECTION** — Higher loads increase compression in packing and thereby cause upper slip segments to engage pipe. Thereafter, increases in casing load are distributed to all slip segments. The yield strength of the pipe is not exceeded at joint strength. Pressure loads are carried directly to the seat in the casing head.

● The "CA" Hanger is of the popular wrap around design which may be dropped or lowered through preventers for automatic setting and sealing, and is interchangeable in all regular Cameron casing heads and spools.

P 432.61 .

The Whys, Whens and Hows of...

Corrosion Protection Of Oil Well Casing

Typical cases of external corrosion on casing recovered from wells in western Kansas. In photo at top, note groove marks above collar.

U.S. Industry investment in casing now over $5¼ billion and growing at rate of $85 million a year. Casing protection can pay dividends. Here's a common sense approach to the problem.

W. C. Koger
Cities Service Oil Company
Bartlesville, Oklahoma

PROTECTION of oil well casing is a subject of vital concern to all corrosion engineers. In discussing a subject as broad as this, it seems reasonable to begin by asking three pertinent questions:

(1) Why should oil well casing be protected?

(2) When should the casing be protected?

(3) How can the casing be protected?

Answering these three questions to the satisfaction of all readers would require a detailed discussion of each phase of the casing corrosion problem. This is beyond the scope of this paper. However, in an effort to overcome this deficiency, numerous references will be made to more detailed discussions of various phases.

Why Should Oil Well Casing Be Protected?

This question is not as ridiculous as it may seem. Very little attention was given to casing corrosion before the early 1940's; so why is it receiving so much attention now? Expensive repair jobs, and in some cases, the loss of producing wells have been responsible for its recognition. Other factors that have emphasized the need for protecting casing are increased productive life due to proration and secondary recovery, increased drilling costs, greater depths and pressures, and possible damage to producing formations. The tremendous investment of the industry in casing has also exerted its influence. It has been estimated that the oil industry has an investment of 5 billion dollars in casing[1] and, based on 1954 completions, this investment is increasing at the rate of $85,000,000 annually.[2]

The preceding discussion has pointed out some of the reasons for protecting the casing against corrosion and this brings us to the second question.

When Should the Casing Be Protected?

Protection should be applied as soon as possible after a corrosion problem is indicated or suspected. There are two reasons for using preventative methods as soon as possible: (1) to avoid expensive repair jobs and (2) to get the well under protection while there is enough steel left to protect.

The ideal time to protect the casing is when the pipe is being set. It is seldom possible to predict a corrosive condition at the time the casing is set; therefore, the procedures used to combat casing corrosion are divided into two groups: (1) those used at the time the casing is set and (2) those used after the well is completed. This brings us to the next question:

How Can the Casing Be Protected?

This question cannot be answered without considering all of the factors involved. It depends on whether the protection is to be applied when the casing is set or after the well is completed; whether the source of trouble is internal or external; and other factors that can influence the installation of protective measures. In fact, most of the work that has been done on cas-

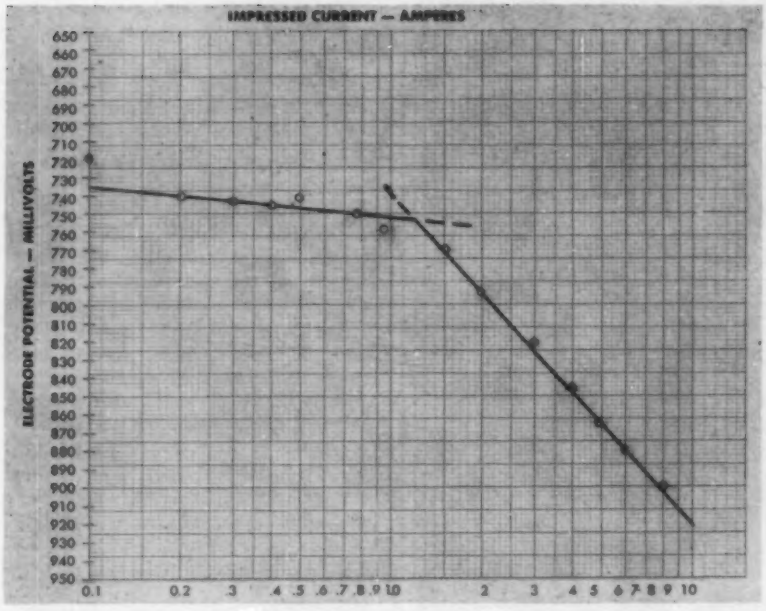


FIG. 1. **Results of typical surface potential measurements** made on casing after applying increasing amounts of current for a definite period of time. These are pipe-to-soil potentials at the end of such a period.

ing corrosion has been designed to answer some phase of this question.

Usually the first indication of a corrosive condition is a casing failure. Since the engineer seldom has an opportunity to examine the corroding member, the cause of failure is not readily apparent. However, a considerable amount of useful information can be obtained from a failure. This information is very helpful in isolating the causative agent.

Internal casing corrosion. Internal casing corrosion has been attributed to the following causative agents:[1]

(1) Acidic gas in vapor space.
(2) Acidic water in fluid zone.
(3) Corrosive gas-lift gas.
(4) Atmospheric oxygen intrusion.
(5) Unspent acid from acidizing operations.
(6) Erosion from sand and fluid.
(7) Instrumentation damage.

Generally, most of these causative agents can be eliminated by considering information obtained from the failure along with the producing history of the well. If internal corrosion is still considered a possibility after examining all facts, a casing caliper survey will usually confirm or disprove this possibility.

A number of preventative methods has been used successfully to combat internal corrosion. These are:[1]

(1) Introduce volatile inhibitors into the annulus.
(2) Set a packer and fill the annulus with an inhibited hydrocarbon.
(3) Intermittent coverage of the internal surfaces with an inhibited crude.[3]

External casing corrosion. The cause of external casing corrosion can be very difficult to determine. Unless the corroding member can be inspected, the information must be obtained with instruments. As would be expected, this can be quite expensive; and in some cases, results are not conclusive. Again, the information obtained from a failure and the producing history of the well can be very helpful in isolating the causative agent.

External casing failures have been caused by the following:[1]

(1) Bacterial attack.
(2) Contact with formations of varying mineral and fluid content.
(3) Electrolysis caused by stray and subsurface electrical currents.
(4) Interference from protected structures.[4]
(5) Galvanic action caused by the presence of dissimilar metals in close proximity.
(6) Metallurgical defects in casing.

Usually, the first approach to the problem of external corrosion is to measure the direction and magnitude of the flow line current. A flow line current of sufficient magnitude to cause trouble is indicative but not necessarily conclusive. Since it is a simple and inexpensive procedure to insulate the well from the gathering system, this should be done immediately and the investigation continued. Several casing failures have been reported in wells insulated from the gathering systems in areas where large flow line currents are common.[4]

The next step in the investigation is to run a subsurface potential profile. Among the first to report the results obtained with this instrument was Ewing.[5] A subsurface potential profile is obtained by taking the potential drop over a predetermined length of pipe from the logging depth to the top of the well. On a conventional log, readings on the left side of the zero line indicate current flowing into the well and readings in the right side of the zero line indicate current flowing out of the well. A negative slope in this curve indicates current leaving the pipe and a positive slope indicates current pickup.

The usual procedure is to isolate the casing string from surface lines and obtain a native state potential profile. If it is desirable to know the influence of the flow line current on the casing potential profile, this information can be determined by another survey with the flow line connected. This tool can also be used to determine the effect of cathodic protection on the well casing.

There are several precautions that should be taken when running the casing potential log.

(1) The casing should be disconnected from all surface lines to obtain the native state log.
(2) Sufficient weight should be attached to the tool to insure good contact between knife contactors and casing. (The contactors should very nearly hold the weight of the tool when readings are taken).
(3) The knife contactors should be hard and sharp.
(4) The insulation between the knife contactors and the tool should be checked each time the tool is brought to the surface.
(5) Spot checks should be made after each run to see if the readings can be reproduced.

It is very important that these precautions are taken. The contactors must break through the scale on the casing walls to obtain readings that can be reproduced. Unless the readings can be reproduced, the survey is of doubtful value.

Very often, the casing potential log will show a severe anodic area at or

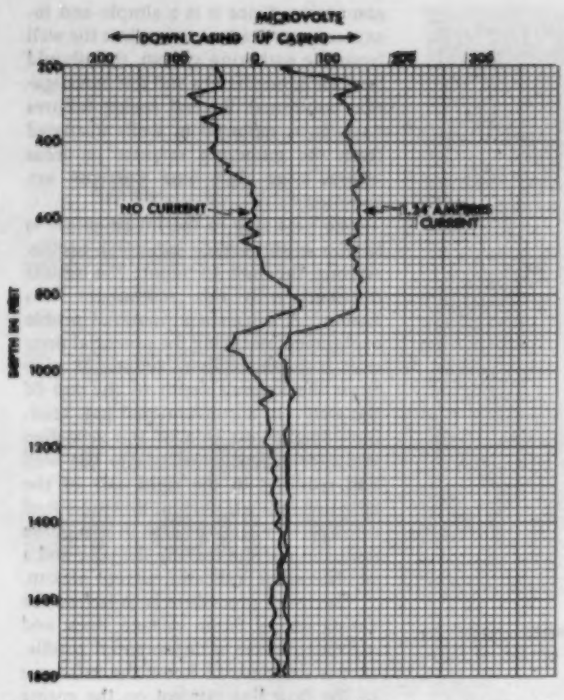


FIG. 2. **Subsurface potential profile** of a well in Rooks County, Kansas, that later developed a casing leak which disproves the theory of impressing a predetermined amount of current for all wells in a given field.

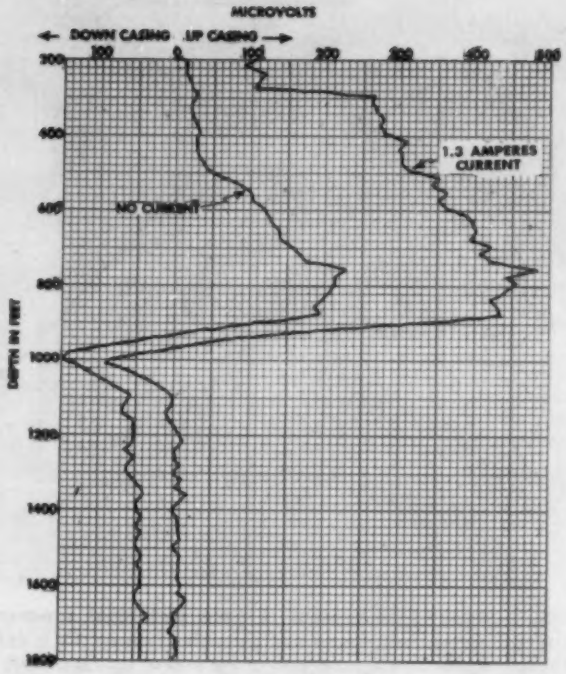


FIG. 3. **Subsurface potential profile** of an offset well to that shown in Fig. 2. Casing in this well was still in good condition after well 660 ft away developed a casing leak with the same amount of impressed current.

near the base of the surface pipe. During the early work on casing corrosion, it was assumed by some investigators that a significant portion of the current was flowing through the fluid from the oil string to the surface pipe and would cause a casing failure at this point.[6] This condition, termed the "surface pipe effect," has been thoroughly investigated by Barrett and Battle and has been found to be the result of metallic contact rather than electrolytic conductance.

Investigation of the external casing corrosion problem has proven that insulating the wells from the gathering system[7] and/or the application of cathodic protection will usually protect the casing against corrosion[2]. Since cathodic protection is one of the few methods of protection that can be used after the pipe is set, considerable attention has been devoted to this phase of the problem.

Current Requirements for Cathodic Protection

The log current potential method of determining the current required for protection is being used extensively. This method consists of applying increasingly larger amounts of current to the casing for a definite interval of time and taking a pipe to soil potential at the end of each period of current application. Results are plotted on semi-log paper, and the curve obtained should be similar to the curve in Fig. 1. Considerable care must be exercised with this method to obtain curves that are significant. Use of this tool has been discussed in detail by Barrett.[2]

Before values indicated by the surface potential measurement are used in a new area, they should be correlated with subsurface measurements. It is entirely possible that certain subsurface conditions will limit its application. However, an explanation of these limitations will require considerably more experience than the industry has at the present time.

Protective Measures

As has been stated previously, the protective methods depend on when the protection is applied. Also, they depend on the corrosive condition that is to be controlled and its location. The methods of protection currently used when casing is set are as follows:

(1) Cementing a long string of surface pipe to the surface.

(2) Cementing the oil string to the surface.

(3) Cementing the oil string through the corrosive zone with the use of a stage cementing collar.

(4) Isolating the casing from a corrosive formation with organic or inorganic gel-type materials.

(5) Using a high pH mud.

Cementing techniques: Certain limitations as well as economic considerations must be weighed with the use of each of these methods.

Long strings of surface pipe cemented to surface have proven to be very effective. This method of protection provides positive isolation of the oil string from a corrosive environment but is limited to shallow applications.

Cementing the oil string to the surface has been used extensively, but a number of casing failures have been reported in wells that have been cemented to the surface. These failures could be caused by a poor cementing job or deterioration of the cement in the presence of sulphate ions. Both of these possibilities should be considered before assuming that the pipe is protected with cement.

Cementing the oil string through a corrosive zone with the use of a stage cementing collar has proven very effective in Kansas. Advantage of this method over cementing the oil string to the surface, is that the cement can be placed at the point of attack. The staging collar is set below the corrosive formation and the casing cemented to the surface from this point. Experience to date indicates that a good cementing

job is obtained by this procedure which effectively isolates the oil string from the corrosive environment. Also, this method is considerably cheaper than either a long string of surface pipe or cementing the oil string to the surface.

Gel-type materials. Another method of protection currently in use is to protect the oil string with either organic or inorganic gel-type materials. This material is displaced through a staging collar set below the corrosive formation. The gel-type material is circulated to the surface. One laboratory reported that organic gel-type materials, currently on the market, provide an excellent environment for bacterial growth. Considering the attention that is being given to bacteria control by the oil industry at this time, it would seem unwise to deliberately encourage bacterial growth. Possibly this condition can be overcome with a bactericide.

High pH muds. The use of high pH muds to protect the oil string has been reported by two operators. Doig and Wachter[8] and later Battle have reported beneficial effects of using high pH muds during drilling and setting casing. High pH muds are expected to keep bacteria dormant, and from all indications, are highly successful in protecting casing from external bacterial attack.

After the well has been completed, all pipe protecting procedures must be applied at the surface. Procedures currently in use are as follows:

(1) Install insulating flanges.

(2) Placement of high pH mud in the corrosive zone.

(3) Application of cathodic protection.

Insulating flanges are used to keep stray currents from entering the wells. Investigators have reported flow line currents in excess of 2.5 amperes in some fields. Considering the fact that one ampere of current leaving a structure will remove 20 lb of metal each year, the harmful effects of currents of this magnitude are apparent.

Placement of high pH mud at the corrosive zone has been used in East Texas but has not proven as successful as was hoped. This lack of success was caused by failure to spot the mud at the corrosive zone and not being able to keep it there. Therefore, this procedure has been practically abandoned in this area.

Cathodic protection. The use of cathodic protection as a preventative method is gaining in popularity throughout the industry. During the past five years, a number of operators have investigated this method of protection and have found it to be practi-

Four Times Longer Life*

from Ampco Polished Rod Liners

...with fewer shut-downs for repairs, less loss of production, lower maintenance costs.

You can retard mechanical wear, corrosion and erosion with Ampco polished rod liners. Even in many of the toughest oil-well services, you can get four times longer life with these remarkable wear-resistant liners—made from Ampco Metal.

Find out today how much money you are spending for sliding wear and corrosion. Check on the "hidden costs" of ordinary liners. Then see how many dollars you can save with Ampco polished rod liners. For more information, just write us.

*Name of this user upon request.

AMPCO® The Metal Without an Equal

AMPCO METAL, INC.
Dept. PE-8 • MILWAUKEE 46, WISCONSIN
West Coast Plant • Burbank, California

PR-22

Reduce your Production Costs

two important ways!...

Fitted with a flexible and resilient ball guide, the PACIFIC Patented* API Ball Valve Cage lowers your production costs by—

1 **Extending the use life of ball valve and cage.**

2 **Extending the runs between pulling the pump to replace worn valves, seats and cages.**

Why a flexible, resilient Ball Guide?

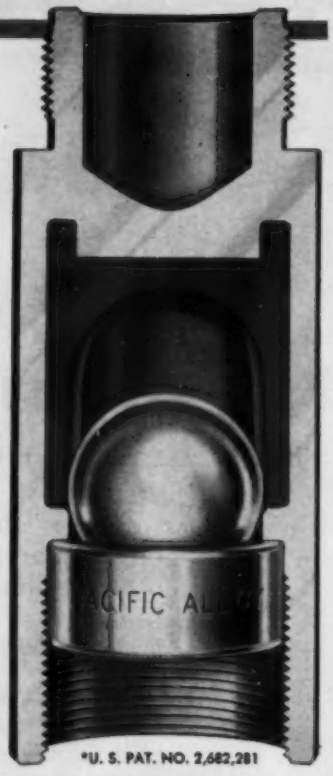
The difference in the capability of a resilient and a rigid material to absorb repeated shocks without permanent deformation is shown graphically by the unretouched photographs below. The ball valve cages are from the same pump.

HERE IS THE ANSWER:

The PACIFIC steel ball valve cage, with a flexible, resilient ball valve guide bonded to the cage, *costs no more* than a standard steel ball valve cage, *yet it will give three to four times the service.*

A PACIFIC steel ball valve cage fitted with a flexible, resilient ball valve guide retains its original shape after 182 days of continuous operation. The ball valve is in good condition and may be easily removed from the cage.

A standard steel ball valve cage with hardened steel ball valve guides permanently deformed after 49 days of continuous operation. The ball valve cannot be removed from the cage.



*U. S. PAT. NO. 2,682,281

PACIFIC PUMPS INC.

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York—
Offices in all Principal Cities
Mid-Continent Division: 1221 E. 1st St., Tulsa, Oklahoma

PACIFIC®

DW16

cal as a means of controlling most of the presently known causative agents. Three methods of obtaining current are currently in use. They are:

(1) Rectifiers.

(2) Galvanic anodes.

(3) DC generators.

The use of rectifiers is limited to those areas where electric power is available. Rectifiers are not limited by soil resistivity as are galvanic anodes and will provide full time protection which is not possible with DC generators. In some areas one rectifier is being used to protect several wells. This procedure can lead to difficulties as has been found in the Hugoton Gas Field.[4]

Galvanic anodes are being used extensively in areas where electric power is not available. Limitations placed on galvanic anodes by high soil resistivity have been partially overcome by using high potential anodes and designing the anode installation for the current requirement. These are important developments, because in certain areas, such as a gas field, neither rectifier nor DC generators are practical.

Several operators are experimenting with the use of DC generators as a source of current for cathodic protection. The problem thus far has been to find a generator that will withstand this service. Ordinary car generators have been used in some instances, but the experience to date indicates that their maintenance is too expensive. The primary trouble has been with dirt getting into the generator. Another point that should be considered before using DC generators is that the protective current is generated only when the pumping engine is operating.

Current Requirements for Cathodic Protection

There has been considerable controversy in the industry over what constitutes protection. Some engineers believe that considerably more current should be used than is required to erase the anodic areas in the subsurface potential profiles, while others want to use a predetermined amount of current based on someone's experience. Both these approaches leave much to be desired. In the first place, unreasonable amounts of current will effectively limit the application of cathodic protection to electrified leases and substantially increase the cost of protection. The use of a predetermined amount of current fails to take into consideration the fact that current requirements can vary considerably between offset wells. Fig. 2 and 3 show the differences in current requirements of wells 660 ft apart. The well in Fig. 2 developed a leak after

When you buy Baroid — you buy the best!

you buy one— you get FOUR

Only Baroid gives you so much for your mud dollar. Service begins with an engineered mud program before you drill.

During operations, Baroid's 24-hour service speeds drilling, prevents trouble, and saves you money.

Complete well reports are filed at Baroid Area Headquarters for planning your future mud programs.

Mud that costs you less is mud backed by the best service — Baroid service. Your total mud program works better, saves you money when you use Baroid all the way. Baroid area headquarters give you fast, complete, localized service. Your best mud buy is BAROID!

BAROID

BAROID

BAROID DIVISION • NATIONAL LEAD CO.
Main Office: P. O. Box 1675, Houston 1, Texas

5609

You Can Depend on Baroid's

FIBERTEX

For preventing or curing lost circulation, nothing equals FIBERTEX...continuously and scientifically improved to seal thief zones. FIBERTEX outsells all other lost circulation materials because it securely seals against the formation; doesn't clog or abrade pumps. Don't waste time experimenting ... use FIBERTEX first!

WHEN YOU BUY BAROID–
YOU BUY THE BEST!

BAROID

BAROID DIVISION • NATIONAL LEAD CO.
Main Office: P. O. Box 1675, Houston 1, Texas

B610

anodes were installed, but the other well is still in good condition.

Corrosion tools. Tools currently used for studying casing corrosion have been responsible for tremendous gains that have been made in this field. Proper use and interpretations of available information eliminates much of the guess work that was necessary in the past. For this reason, engineers just entering this field should study very carefully the work that has already been done and familiarize themselves with the use of these tools. Also there are certain limitations that should be observed in interpreting these data to avoid drawing conclusions that are not warranted. Much of the disagreement that exists at the present can be resolved by observing these suggestions.

References

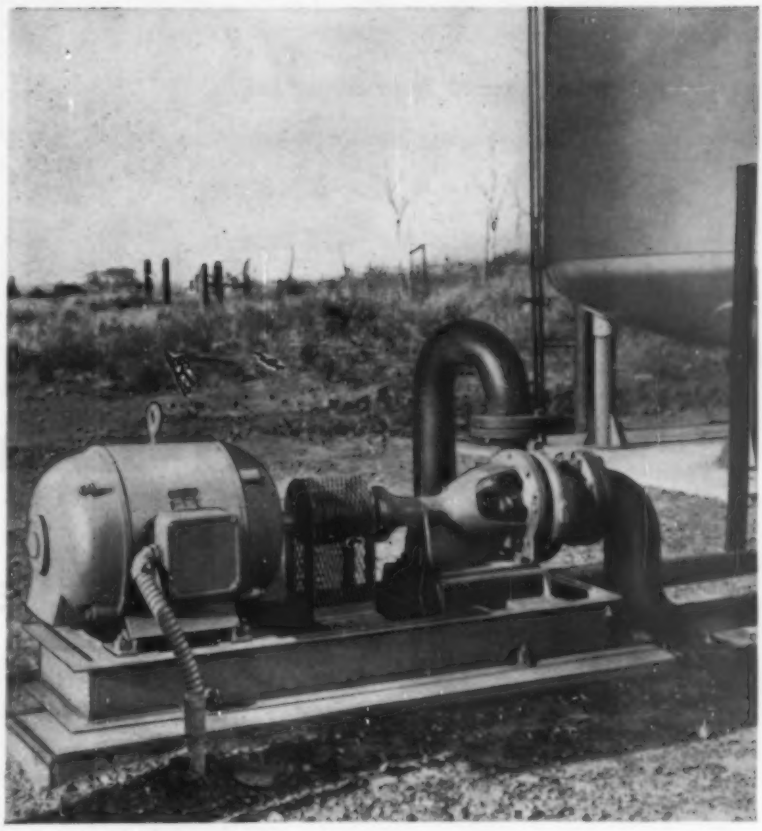
1. Battle, Jack L., "Corrosion of Casing in Oil and Gas Wells," presented at NACE Conference, Chicago, Illinois, March 16-20, 1953.
2. Barrett, J. P., and Gould, E. D., "Cathodic Protection of Oil Well Casing," presented at NACE Conference, Chicago, Illinois, March 7-11, 1955.
3. Caldwell, J. A., and Lytle, M. L., "Internal Casing Corrosion in Sour Oil Wells," *Corrosion*, Vol. 12, No. 2, February, 1956, p. 67.
4. Koger, W. C., "Casing Corrosion — Hugoton Gas Field," presented at NACE Conference, New York, New York, March 12-16, 1956.
5. Ewing, S. P., and Bayhi, J. F., "Cathodic Protection of Casings in London Pool," *Corrosion*, Vol. 4, No. 6, June, 1948, 264.
6. Sudburg, J. D., Lunders, J. E., and Shock, D. A., "External Casing Corrosion Control," presented at Fall Meeting Petroleum Branch AIME, San Antonio, Texas, October 17-20, 1954.
7. Hammond, R. E., and Ewing, S. P., "Protection of Well Casing Against External Corrosion," *World Oil*, Vol. 132, No. 2, February 1, 1951, p. 154.
8. Doig, K., and Wachter, A., "Bacterial Casing Corrosion in the Ventura Field," *Corrosion*, Vol. 7, No. 7, July, 1951, p. 212.

Acknowledgment

Presented by the author under the original title "Protection of Oil Well Casing" at the Third Annual Corrosion Control Short Course sponsored by The University of Oklahoma at Norman, April 3-5, 1956. ★ ★ ★

Drilling Starts From Shell's Newest Permanent Platform

The newest piece of equipment put into operation by Shell Oil Company in the search for oil in Louisiana coastal waters is a huge permanent drilling platform, which has just begun drilling its first exploratory well. The structure is in 48 ft of water about 45 miles from the coast of St. Mary Parish in Eugene Island Area Field 128, Block 116, leased jointly with Union Producing Company. Twenty-nine steel piles penetrating the sea bottom for 140 ft support a drilling deck 82 by 96 ft, large enough to hold all the pipe, mud and cement needed. The derrick can drill 6 wells while in one position and then can be shifted along the deck to drill 6 more. This is made possible by shifting the crown block inside the unusually enlarged water table.



A Centrifugal Pump Salt Water Can't Damage!

Ampco Pumps are ideal for salt-water disposal and flooding operations:

- *Transfer service*
- *Pumping over aerators*
- *Pumping through filters*
- *Back-flushing filters*
- *Delivery of treated water*

It's an AMPCO . . . made from aluminum bronze that contains no zinc.

Ampco Pumps resist corrosion, erosion, abrasion, cavitation-pitting, and dezincification. They are made from Ampco alloys engineered specifically to resist salt water corrosion.

Durability isn't the only advantage of Ampco Pumps. They have high efficiency . . . up to 85%. You pay considerably less for power.

Ampco Pumps are available in more than 100 different combinations, with speeds from 1750 to 3500 rpm; capacities to 600 gpm; heads to 300 feet.

Contact us in Milwaukee for the name of your nearest AMPCO PUMP DISTRIBUTOR.

AMPCO®

AMPCO METAL, INC.

Dept. PE-8, Milwaukee 46, Wis. • West Coast Plant: Burbank, Calif.

THE METAL WITHOUT AN EQUAL

P-23

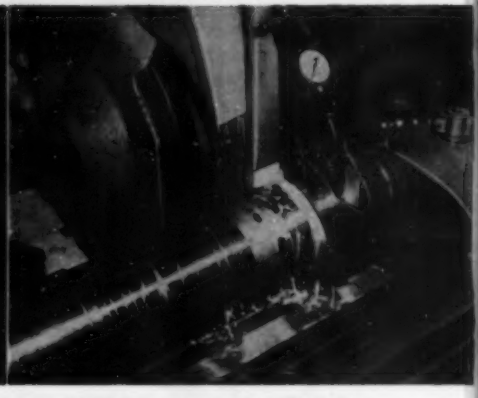
Quality

CARDWELL BACKS US WITH

WE'RE DOING THIS TO GIVE YOU A BETTER

You get...smooth running, proper balance and longer life from your brake flange because of precision machining.

You get . . . longer wearing gears and sprockets because of our modern electronic induction hardening process.



You get . . . proper bearing fit and longer bearing life because of our grinding of bearing seats to .0001 exact tolerance.

CARDWELL

CARDWELL MANUFACTURING COMPANY • Box 2001,

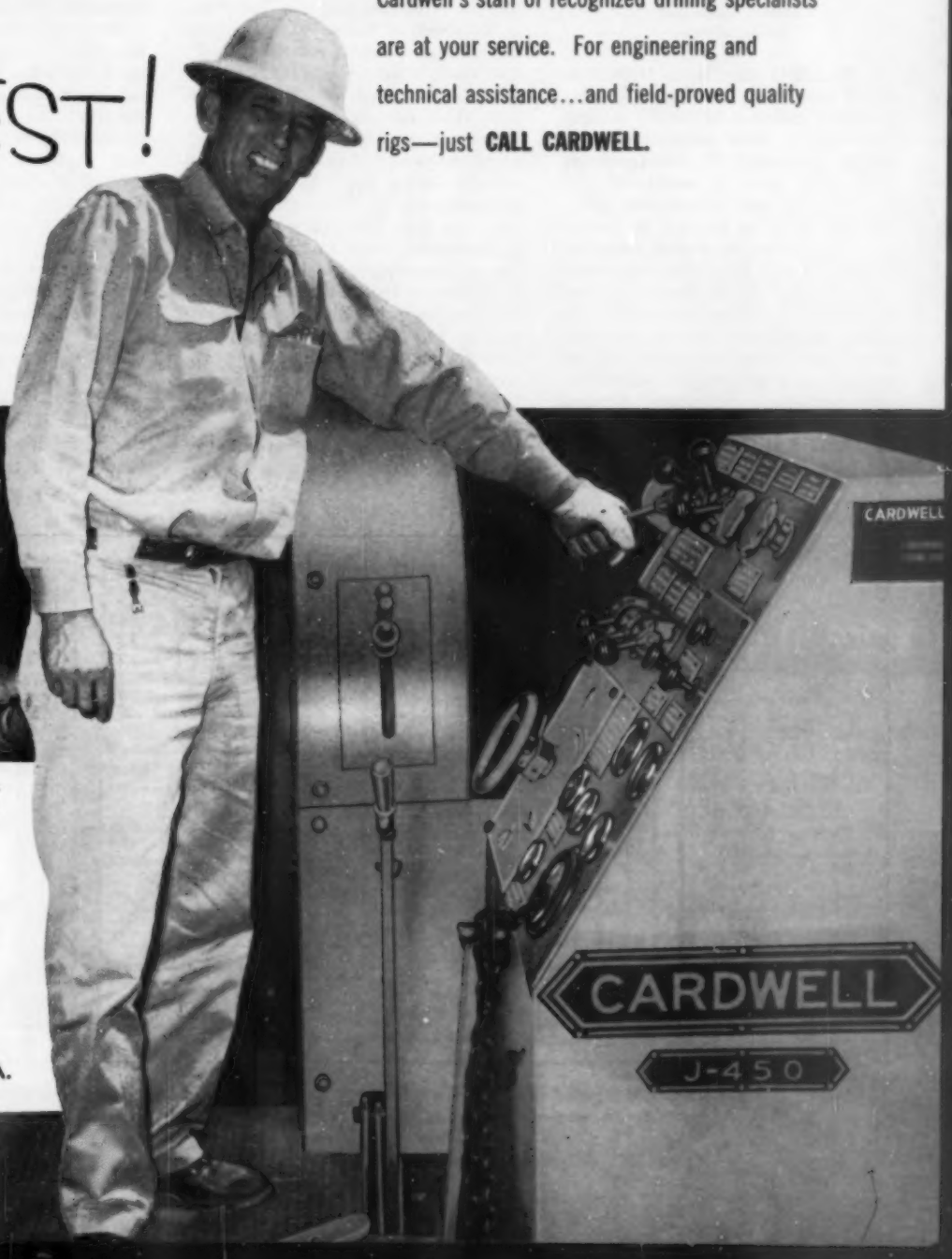
...And Pete Westbrook, drilling superintendent for Breuer-Robison, should know! Over the past 30 years, in major Southwest and Midwest fields, he has learned to depend on Cardwell quality for higher performance ...less down time and that extra margin of reserve power that makes the big difference.

Cardwell's staff of recognized drilling specialists are at your service. For engineering and technical assistance...and field-proved quality rigs—just **CALL CARDWELL.**

THE BEST!

RIG

You get...maximum rig-part life. Our rigid inspection techniques insure it.



Wichita, Kansas, U. S. A.

Acid Spearhead Helps to . . .

Increase Fracturing Efficiency

By removing mud cake, treating pressures lowered, injection rates increase and stimulation results are improved.

J. K. Henderson
Chief Field Engineer
Dowell Incorporated
Tulsa, Oklahoma

INCREASED stimulation from fracturing treatments and lower treating pressures sufficient to permit successful fracturing have resulted from the proper application of mud-dissolving acids. This acid, a combination of hydrochloric and hydrofluoric acids, has the ability to dissolve or disintegrate clay materials, such as bentonite, in drilling mud. Use of an acid spearhead in front of the fracturing fluid permits the fracturing treatment to be conducted at lower injection pressures, while maintaining sufficiently high injection rates to prevent screenouts. The necessary inhibitors, wetting agents and emulsion prevention agents in the acid spearhead contribute toward a successful fracturing treatment.

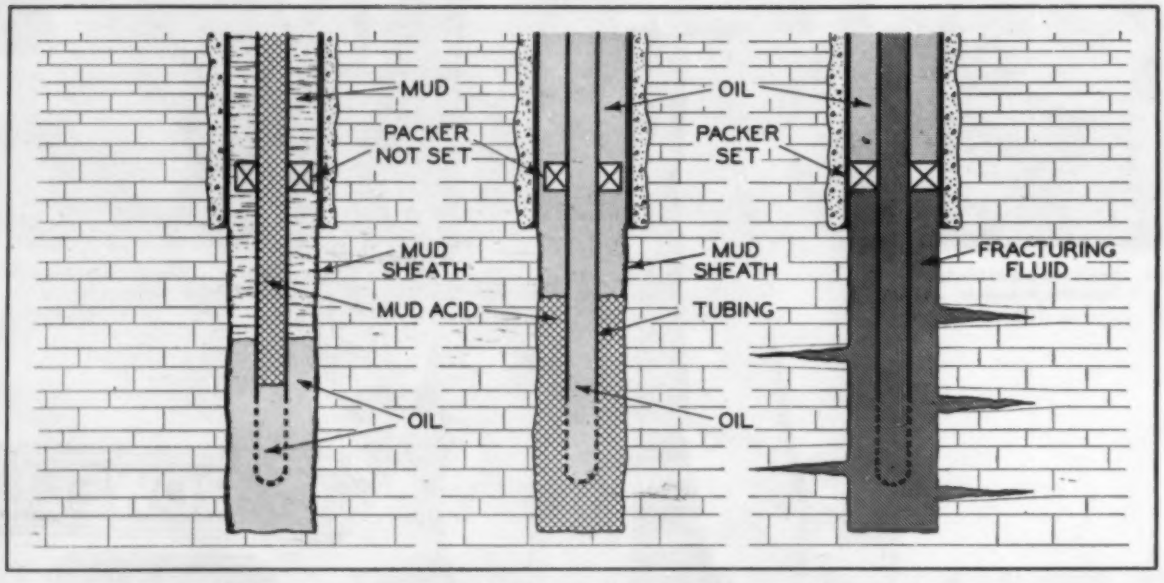
Screenouts in the well bore are caused by failure to inject the sand into the formation properly. This often is the result of decreased velocity of the fluid as it enters a "mudded off" formation, resulting in sand being filtered or "screened out" into the well bore. This may be overcome by increasing the pump rate (to the capacity of the pump) to provide additional velocity to the sand. As the treating pressure goes up, however, the injection rate goes down (when operating at maximum horsepower), since the rate of pumping varies inversely with the pressure. This is a waste of power. Because high injection rates permit putting away additional amounts of sand for maximum production boosts, some method of increasing the formation's ability to accept sand at lower pressures is desirable.

This acid has been employed to disintegrate residual mud cakes, destroying their colloidal properties, and allowing fracturing fluids to enter the formation at reduced pressures.

How acid helps. Several explanations have been advanced for the beneficial effects that have been obtained by using a mud-dissolving acid ahead of the fracturing fluid. By increasing the permeability of the mud cake, the acid may, in effect, transform the breakdown fluid from a non-penetrating to a penetrating fluid, and make possible opening a horizontal rather than a vertical fracture.[1]

Another explanation is that acid attacks the cementing materials in the formation, weakening them and permitting good clean fractures to be obtained at lower pressures.

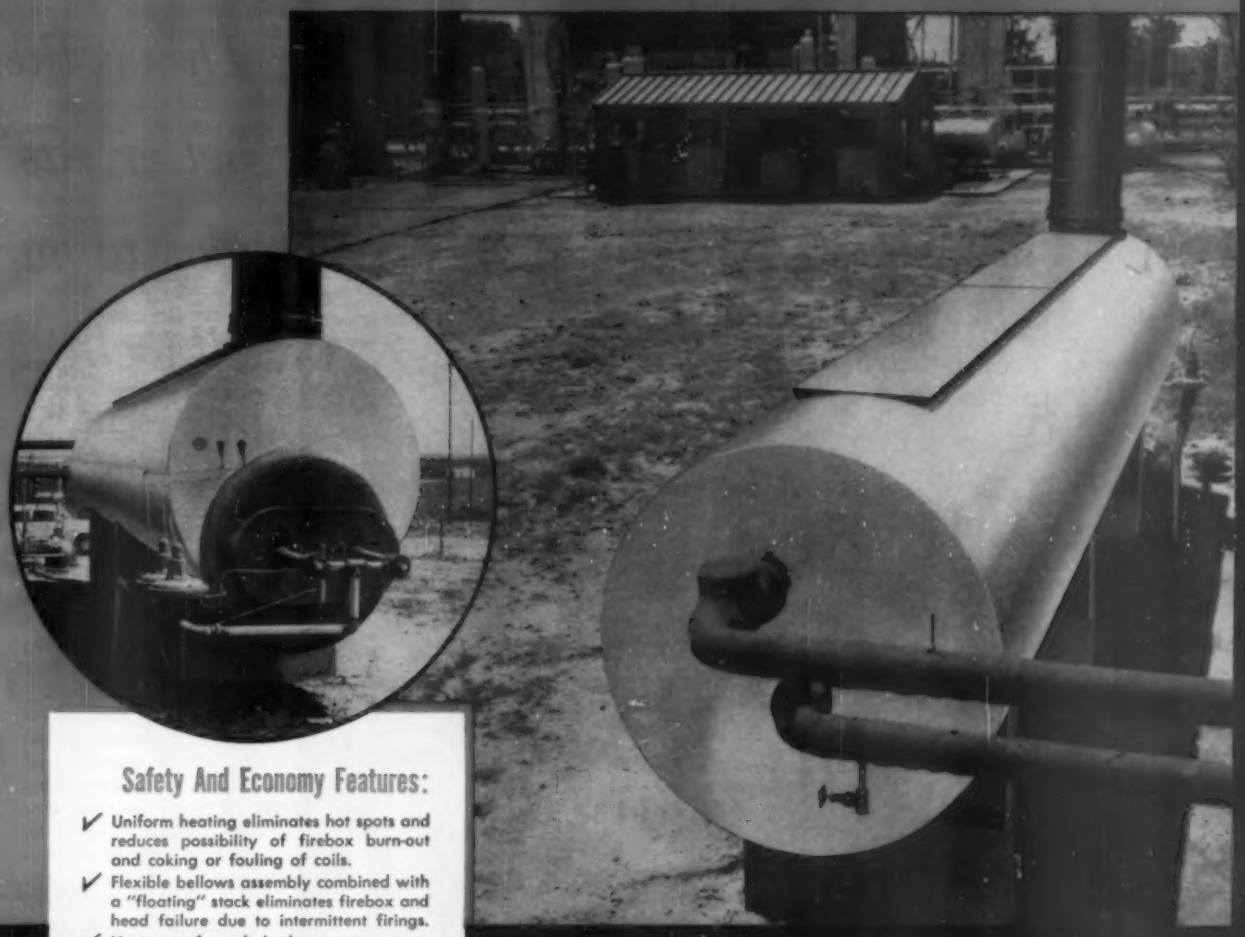
It has also been suggested that, because the heaviest mud cake tends to form over the most permeable section during drilling operations, unless this mud cake is removed, the fracturing



Acid spearhead is spotted on bottom before packer is set in fracturing treatment. By disintegrating the mud sheath, fracturing pressures have been lowered.

New BS&B Salt Bath Heater

Provides Safest Method Of High Temperature Heating!



Safety And Economy Features:

- ✔ Uniform heating eliminates hot spots and reduces possibility of firebox burn-out and coking or fouling of coils.
- ✔ Flexible bellows assembly combined with a "floating" stack eliminates firebox and head failure due to intermittent firings.
- ✔ Heat transfer salt bath operates at atmospheric pressure, and therefore cannot cause vessel rupture.
- ✔ Molten salt is non-corrosive to carbon steel, non-volatile, thermally stable and non-toxic.
- ✔ Ample space for the salt has been provided to prevent "boiling over". Salt requirements have been minimized for greater economy.
- ✔ Reliable BS&B heater controls with dual temperature controls are standard equipment. BS&B pilot light permits either snap-acting or throttling burner controls with minimum possibility of pilot failure.

...Provides Uniform Heating Up To 800°F.!

BS&B now offers a complete new line of Salt Bath Heaters with capacities ranging from 75,000 to 6,000,000 BTU/Hr. A wide selection of coils of various sizes and pressure ratings makes them adaptable to virtually any application requiring uniform heating up to 800° F.

These units are ideally suited for the heating of oil, paraffins and gas (as in the reactivation of dry desiccant dehydrators). They may also be used in fractionater reboiler service and other low pressure drop applications.

For complete details on the new BS&B Salt Bath Heater, contact your nearest BS&B Representative, or write to . . .

OVER 60 YEARS
BS&B
EFFICIENCY RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Oil & Gas Equipment Division, Dept. 1-C8
1708 West Main Street, Oklahoma City, Oklahoma

This is the better, easier way to pump oil wells...

IT IS, OF COURSE, THE KOBE HYDRAULIC OIL WELL PUMPING SYSTEM

Because...IT COSTS LESS TO INSTALL

IT COSTS LESS TO MAINTAIN

IT COSTS LESS TO OPERATE

IT OFFERS A SIMPLE SOLUTION TO PRODUCTION PROBLEMS

IT SIMPLIFIES LEASE PLANNING

IT IS 100% SALVAGEABLE

Free Pump®

KOBE

HUNTINGTON PARK, CALIFORNIA

materials will be diverted into the less permeable zones. Fractures in such sections are highly desirable. Moreover, this is believed to make possible multiple fractures. When the mud sheath is removed by the use of this acid, the breaking pressure is greatly reduced as a result of opening the permeability of the entire producing formation. The pressure of the fracturing fluid is thus applied over the entire exposed formation, and as one fracture is opened and then packed off with sand, other fractures may be opened by relatively slight increases in pressure. This series of small pressure breaks is generally hidden by the friction pressures. They can be observed, however, on a pressure recording made on a static head side, regardless of whether the job is run down the tubing or the casing.

The fracture theory. A recently introduced theory states that new fractures are not created as a result of treatment, but rather that fractures already present in the formation are exposed during the drilling process. The fracturing treatment is believed to open up these fractures and place a propping agent in them. In line with this theory, where no exposed fractures are present, this type acid is employed to open up flow channels intersecting the naturally occurring fractures and planes of weakness and connect them with the well bore.

Early treatments using a mud-dissolving acid in conjunction with fracturing operations were made in Montague County, Texas, on a conglomerate formation. Treatment of these wells was initiated using the conventional acidizing technique of spotting the acid opposite the producing zone. The acid was pumped slowly to allow sufficient time for reaction so as to insure maximum dissolving and disintegration of mud and formation particles, before the fracturing fluid was injected into the formation. A flush consisting of the tubing volume of oil was then pumped down, and the hole swabbed before pumping the fracturing materials.

Experience in the area indicated that when a treating pressure of 2000 psi was required to inject the breakdown fluid, a screenout often occurred when the more viscous fracturing fluid entered the formation. Use of this acid reduced the breakdown pressure below the 2000 psi and permitted successful injection of the fracturing materials.

It was found that the results of the fracturing treatment were not adversely affected by not removing the spent acid before injecting the fracturing materials. This permitted savings in rig time and treatment expense.

Acid injection methods. Several methods have been used to inject this

lost circulation

Strata-Fiber

IS THOROUGHLY DRY

Seventy per cent of **Strata-Fiber** is dehydrated fibers from the inner rind of sugar cane bagasse. But these fibers have been so thoroughly dried that you buy *more* active lost circulation material per pound than with any similar product. This extra drying plus the fact that **Strata-Fiber** is made from the tough inner rind makes it your best buy in a fibrous lost circulation material.

Strata-Seal

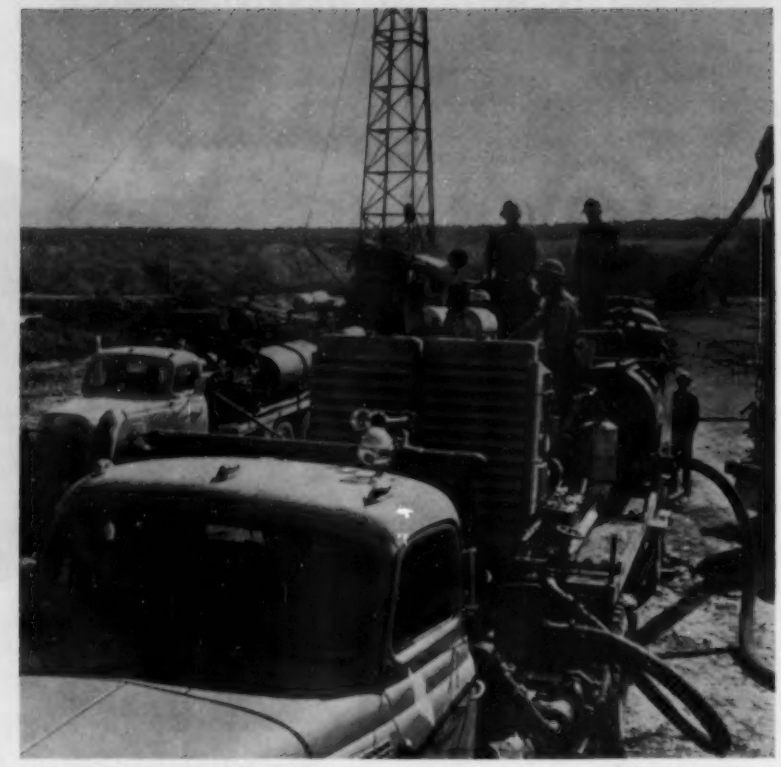
Strata-Seal has both a plugging and a bridging action. The perlite particles pack tightly in the fractures of the formation. This tight packing strengthens the troublesome formation making it more impermeable, thereby less susceptible to reoccurrence of lost circulation. Can be obtained from drilling mud distributors.

GLC

GREAT LAKES CARBON CORPORATION—PERLITE DIVISION

P. O. Box 2050

Houston 1, Texas



Pump trucks on location during fracture treatment of well in background. Acid spearhead made possible higher injection rates and lower fracturing pressures.

type acid into a formation. In the first of these methods, the acid is pumped immediately behind the breakdown oil in order to clean up the newly opened fracture. A second method, often preferred, is to spot the acid opposite the pay before breaking the formation. This method is designed to expose the entire producing zone to the introduction of the fracturing materials and should increase the likelihood of securing multiple fractures.

When this second method of treating is employed, a prolonged treatment is indicated, due to the relatively slow reaction rate of the acid. It must be allowed to remain in the critical area of the well sufficiently long for the chemical reaction to take place. Otherwise, little more than a partial shrinkage of the silicates occurs; and ordinary low surface tension acid would be as effective. The mud-dissolving acid is allowed to remain in contact with the mud sheath for a sufficient length of time for initial reaction to be complete. The acid is then displaced into the formation slowly in order to enlarge flow channels. A minimum of 200 gallons is considered necessary, however, the exact amount used is based on well conditions.

Another stimulation method, commonly called a combination treatment, has proved particularly successful in some areas. This consists of a fracturing treatment followed immediately by acid. The theory of this technique is that the acid entering the newly opened fractures not only cleans them out but enlarges openings in the matrix so that better drainage from the fracture faces can be obtained.

Effect of acid. The effectiveness of this type acid in succesfully improving the results of a fracturing treatment is illustrated by a treatment of a well completed in 1950. Production on this well had declined to less than 1 bbl of oil per day and a show of gas. The operator decided to treat the well, completed in a sandstone formation, with a 3000 gal Sandfrac treatment using 1 lb per gallon sand. First, the formation was broken down with crude oil. This preliminary breakdown pressure indicated that the treatment could not be conducted at a satisfactory injection rate without exceeding the maximum allowable injection pressure (2600 psi) specified by the operator.

In order to reduce the treating pressure and increase the injection rate, 200 gal of acid was bled to the bottom of the tubing. The casing valve was then closed and the acid displaced into the formation. During this stage a maximum treating pressure of 2100 psi was reached. By the time the last of the acid entered the formation, the pressure had dropped to 750 psi. Lease oil was then pumped and a maximum injection rate of 4 bbl per minute at 1400 psi was attained using the available pumping equipment. Next, the fracturing materials were injected into the formation. Treating pressure did not exceed 2000 psi, breaking to 1500 psi as the last of the fracturing materials entered the formation. The average pump rate during the injection of the fracturing materials was 3¼ bbl per minute.

The well was then overflushed using 51 bbl of oil, and the pressure dropped from 750 psi to a vacuum, in approximately one minute. After a period of flush production this well levelled off at 11 bbl of oil per day and 3 Mmcf of gas. Although this amount of stimulation from a fracturing treatment is not particularly outstanding, it does point out the ability of acid to improve the results of the treatment by reducing injection pressures and making possible increased pump rates.

Fracturing pressure lowered. Another example of this type of treatment was on a well in Young County, Texas. A fracturing treatment using sand and oil was unsuccessful. After approximately 600 lb of sand had been injected into the formation at 3100 psi, a screenout occurred. The fracturing fluid would not return to the well bore. Apparently, a non-productive or low permeability section had taken the sand. The acid was spotted and allowed to soak for 15 minutes, in order that it might penetrate any mud sheath that might be blocking the permeable zone. The well broke from 2100 psi back to 1400 psi. Acid was injected slowly over a period of 30 minutes followed by the fracturing fluid. The maximum pressure encountered was 1900 psi while the 3000 gals of fracturing materials were being injected. The well responded making 36 bbl of oil per day, and, after 3 years, is still making 9 bbl per day.

Summary. Mud-dissolving acids have proven their value by making possible the fracturing of oil-bearing formations at lower working pressures. They disintegrate the mud sheath and open up flow channels, permitting more fractures to be formed at lower treating pressures. Moreover, the dissolving power of the combined hydrochloric and hydrofluoric acids produces increased permeability in the critical area surrounding the well bore, resulting in increased production.

Reference

1. Scott, P. P., Jr., Bearden, W. G., and Howard, G. C.: *Trans. AIME*, 1953, 198, 111.

Big new rig for customer in trouble shipped five hours after order!

This happened recently in Louisiana. The pressure in a 12,000-ft. well blew from below like a volcano and cratered the rig. By 4:00 p.m. that day, the contractor had surveyed the damage and was on the phone to National Supply's New Orleans office. "How fast could you deliver a new rig?"

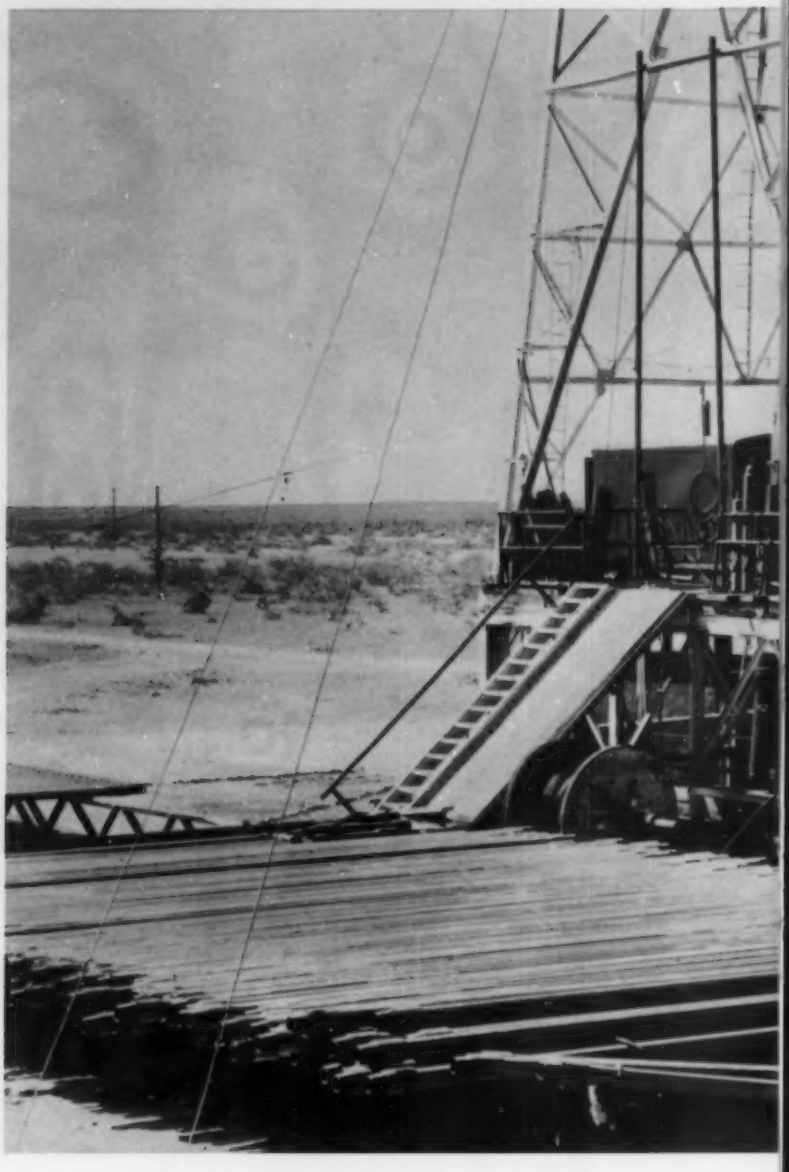
Our 103-station teletype system hummed. At 7:00 the next morning, we told him we could deliver a National 130 rig—second largest rig in our line—from stock. Four hours later, the customer ordered. Just before 4:00 that afternoon, the big new rig was loaded on a trailer truck and on its way.

Obviously, we were lucky to have such a large rig in stock at that moment. We cannot guarantee to repeat this rapid performance on call. But we *do* guarantee—and this goes for all of the many quality products available from National—service as fast as the National "team" can give it.

We'd like you to know more about this National Supply team—even if your oilfield needs may not be great and top speed very essential. It's made up of six plants, 126 strategically-located supply stores and, most important, 10,000 experienced people working to give you the best in oilfield supply service. See us or call us for action soon, and we'll prove it to you.

THE
NATIONAL SUPPLY
COMPANY

← TWO TYPES TO



SPANGWELD

DRILL PIPE

- **Joints flash-welded to drill pipe**
- **Streamlined exterior contour**
- **Threaded elements reduced**
- **Sizes for every drilling requirement, including slim hole operations**

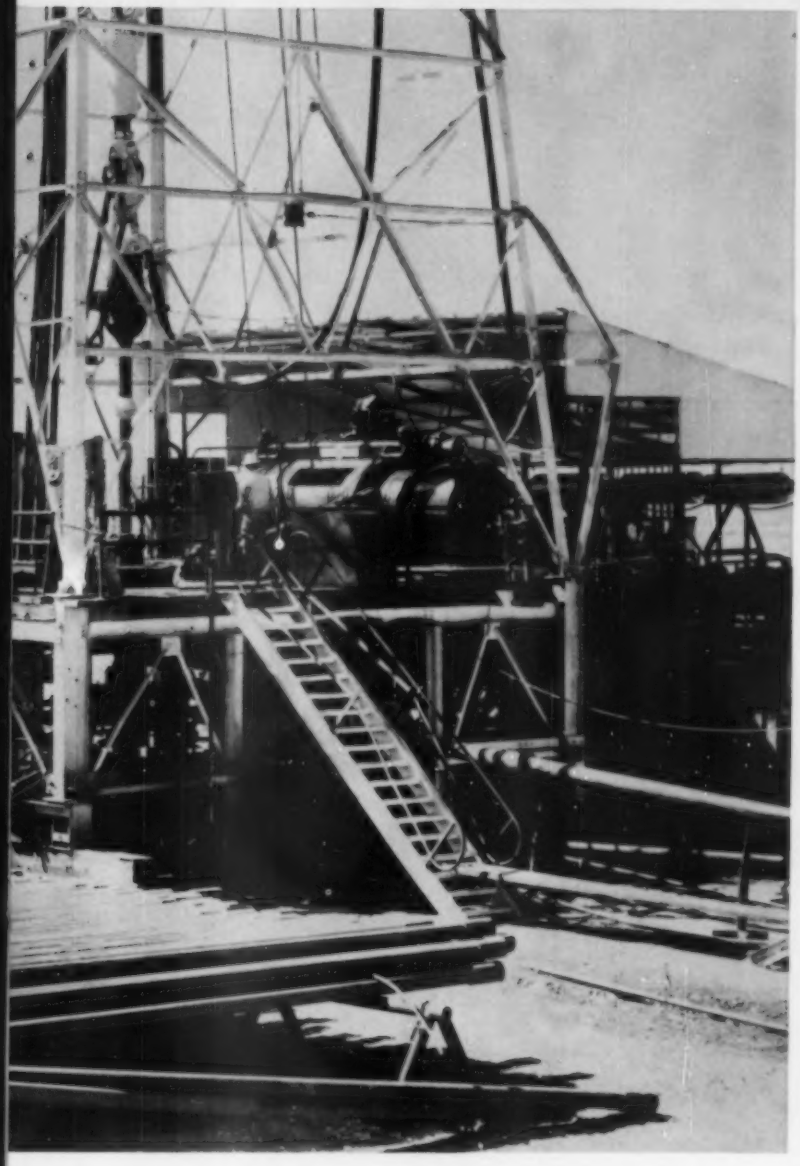
Guard against drill pipe failures with

If the severe stresses and pressures of deep well drilling have caused costly drill pipe failures in your operations, you'll find it profitable to use these top-quality SPANG Tubular Products. Developed to withstand hard service, both Spangweld and SPANG Double Seal Shrink Thread Drill Pipe are highly resistant to fatigue, tension and corrosion* failures.

You can see the reasons for this stamina by examining both types of tool joints. Streamlined Spangweld Drill Pipe has only one-third of the number of threaded elements in conventional drill pipe and tool joints. In SPANG Double Seal Shrink Thread tool joints, two precision metal-to-metal seals eliminate leakage and washouts and prevent fluid entry into the threads. Full broad thread contact in every pipe thread and a root supported by a tool joint thread crest also minimize the effects of fatigue stresses. Whenever necessary, SPANG Double Seal Shrink Thread tool joints can be quickly replaced at the rig.

For highly abrasive service conditions, both Spangweld and SPANG Double Seal Shrink Thread tool joints are available with several types of hard facing. All of these quality features are outstanding reasons why you get maximum protection against failure when you specify dependable SPANG Drill Pipe.

MEET YOUR NEEDS!



SPANG®

DOUBLE SEAL SHRINK THREAD DRILL PIPE

- **Completely seals against internal and external pressures**
- **Joints rapidly replaced at the rig**

***Specify SPANG Plastic Coating for maximum corrosion resistance!**

After carefully-controlled shot-blasting and cleaning operations, a tough epoxy-phenolic internal surface coating is applied by alternate spraying and baking. A uniform thickness of not less than .005 inches is the result. Ask the National representative in your area about this service—and any other details you'd like to have about SPANG Drill Pipe.

SPANG® DRILL PIPE!

THE NATIONAL SUPPLY COMPANY

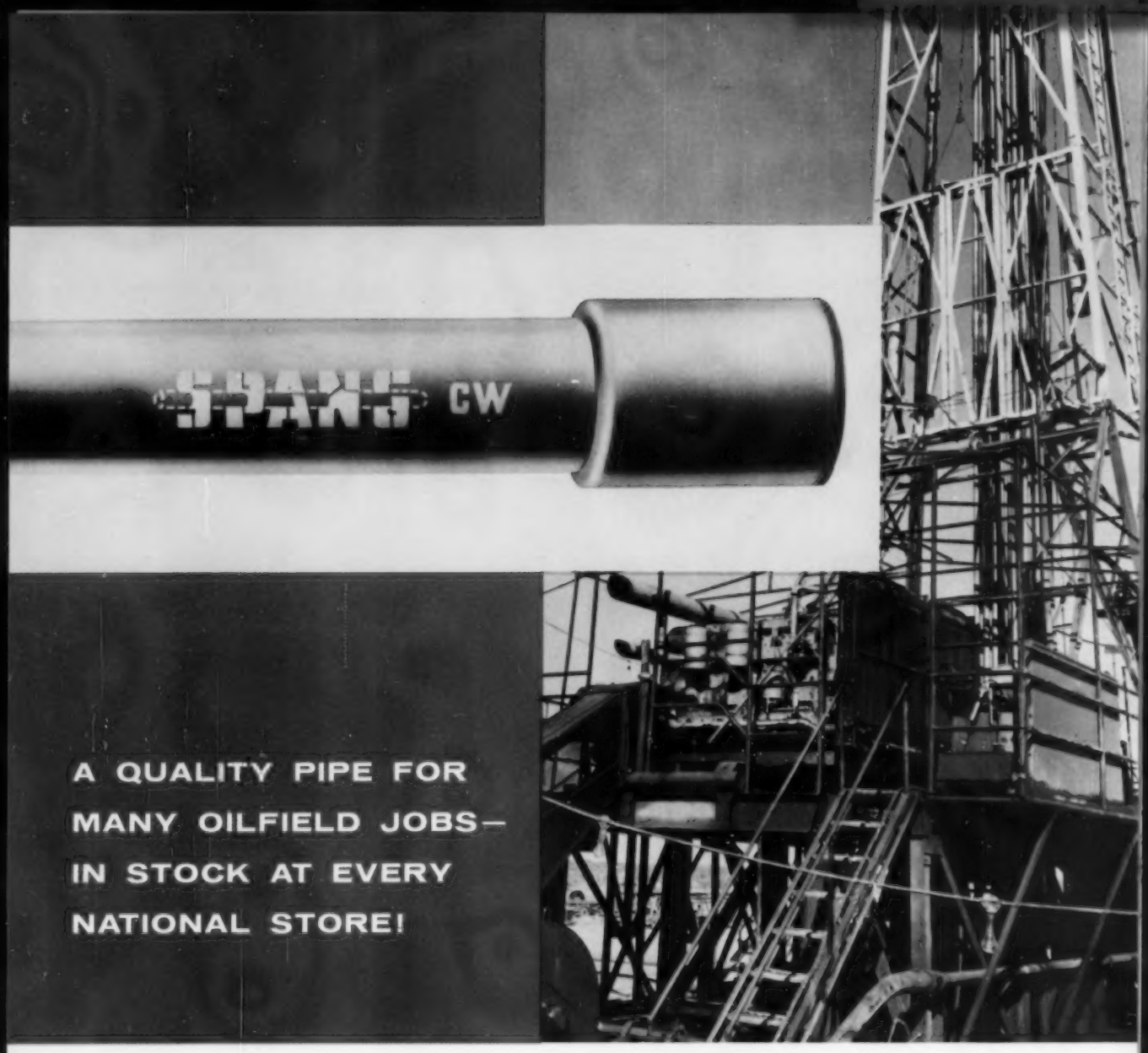
SPANG-CHALFANT DIVISION

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.

DIVISION TUBULAR OFFICES: Denver, Colorado; Houston, Texas; Ft. Worth, Texas; Los Angeles, California; Toledo, Ohio Tulsa, Oklahoma; Calgary, Alberta, Canada

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

On the next page . . . a top-quality pipe for general service work



A QUALITY PIPE FOR MANY OILFIELD JOBS— IN STOCK AT EVERY NATIONAL STORE!

SPANG CW Steel Pipe is available at every National Supply Store in a full range of sizes—and, most important, there's no extra cost for its special quality.

In countless oilfield applications, SPANG CW has consistently proved itself for dependable general service work. That's because it's made under close quality control conditions—like all the other famous SPANG oilfield tubular products. The manufacturing care behind SPANG CW makes it easy to work with and install. Thorough tests and inspections before shipping insure its top strength and long service life—features that pay off wherever you put it to work.

SPANG CW Steel Pipe is especially useful for waterflooding, air, gas and salt water disposal lines, water and oil gathering systems.

Try it on your next job.

THE NATIONAL SUPPLY COMPANY

SPANG-CHALFANT DIVISION

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.

DIVISION TUBULAR OFFICES: Denver, Colorado; Houston, Texas; Ft. Worth, Texas; Los Angeles, California; Toledo, Ohio Tulsa, Oklahoma; Calgary, Alberta, Canada

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

Modernistic drafting department is the center for Sunray Mid-Continent's drafting operations. It features ample space, good lighting, modern equipment and "piped" music.

Drafting Department gets 'NEW LOOK'

EXCLUSIVE

Sunray Mid-Continent put the best in and gets the best out of its streamlined drafting dept.

John Morris
Sunray Mid-Continent Oil Company, Tulsa, Oklahoma

PROBABLY no other professional man in an oil company is so constantly exposed to people looking over his shoulder as is the draftsman. Very few occupations "chain a man to his desk" more than does drafting. Few, if any, employees in an oil company require more desk space in which to work than a draftsman. None require better lighting.

Considering all these factors, it is understandable why a drafting department is deserving of the best working conditions. It was such an understanding in 1953 that prompted Sunray Mid-Continent Oil Company in Tulsa to abandon its existing setup and give the green light to a complete overhaul of all its drafting operations.

Not that the old system was the worst in the business . . . not by any means. But, as is the custom still in many companies, draftsmen were stuck in various departments in hidden nooks and crannies. Lighting was sometimes make-shift; equipment varied according to departmental needs; duplications were numerous on some more expensive tools that are used only occasionally; draftsmen took instructions from supervisors who frequently understood little of the possibilities and limitations of drafting; information was difficult to find in a hurry; and most draftsmen suffered feasts and famines in their work schedules.

It was when this situation became glaringly apparent that Sunray Mid-Continent decided to act. A study of the various drafting operations was made; working conditions were surveyed; work-loads were analyzed; equipment was inventoried; duplication of work and equipment was assessed. The entire drafting structure was diagnosed and found adequate but not streamlined. The streamlining got under way fast in 1953.

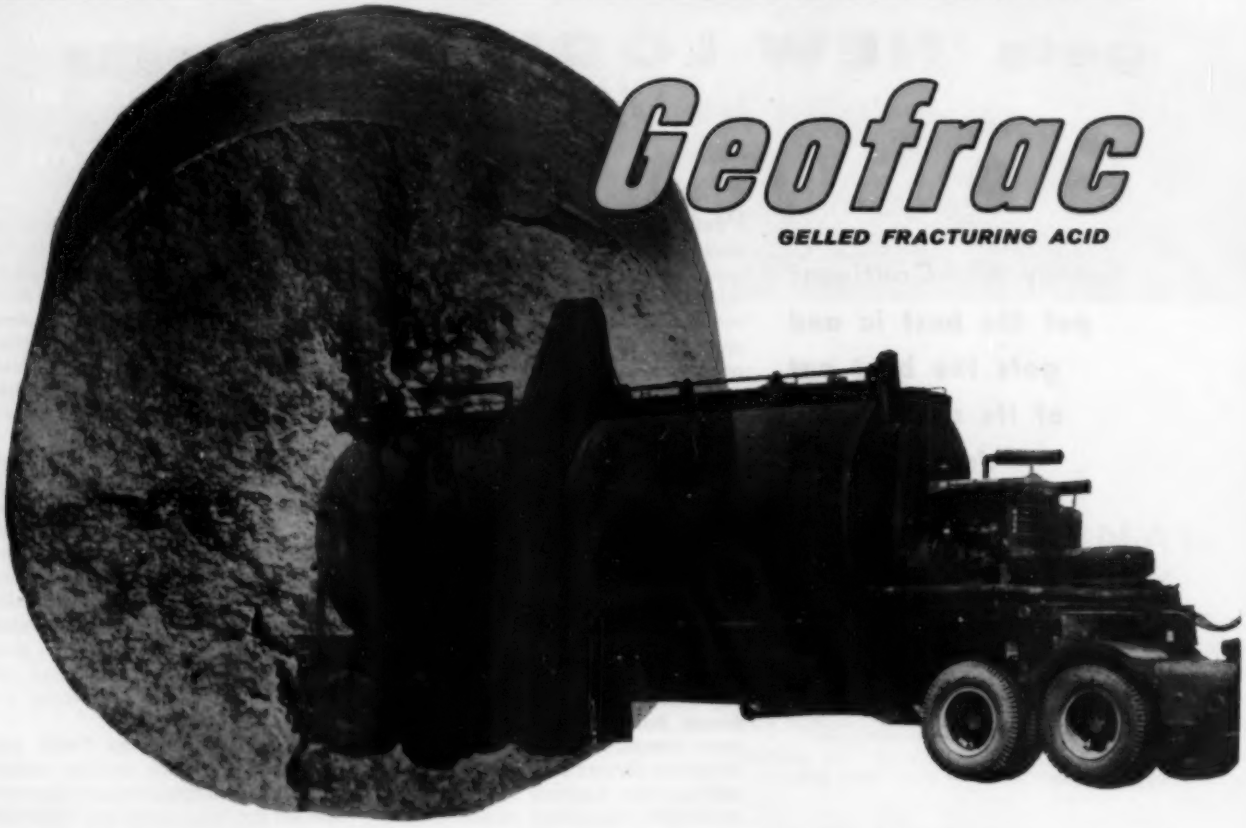
Centralized operations. Today, Sunray Mid-Continent's drafting section provides all mapping and drafting services for the entire company. All drafts-

Adequate and organized map filing facilities for rolled maps stored in tubes. Folded maps are filed in cabinets. The correct map is available without confusion or delay.

Master map is referred to by author John Morris, manager of Sunray Mid-Continent's drafting department. Shaded area denotes sections which can be found in the map storage room.

men are located in one large centrally located room at company headquarters. It is believed, albeit immodestly, that the company's drafting quarters today are the most modern and efficient in the industry.

Physically, the area is attractive. Wide halls in the room permit draftsmen to move about freely with large, freshly inked maps. Tables are spaced to give draftsmen room to operate expansively instead of restrictively. Every automatic and mechanical tool that is practical for a particular draftsman is within arm's reach. Fluorescent lights have been placed diagonally across the ceiling to eliminate shadows on the draftsmen's work. Temperatures are



controlled the year 'round, thus providing draftsmen with physical comfort and assuring the workmen of moisture-free hands. Soft music is piped into the room through an overhead speaker.

This streamlining brought on one unanticipated development. With such a modern setup, the drafting section has now become a showplace for company guests and visitors. Traffic is thick at times. The draftsmen, fortunately, have become accustomed to being watched "over the shoulder" and, like good troupers, have learned to go on with the show for a full audience or empty house.

Five drafting groups. The drafting section at Sunray Mid-Continent is divided into five groups for operating purposes: Utility, Development, Land, Geophysical, and File groups.

During 1955 the Utility group alone handled 1047 different types of jobs ranging from drawing cartoons to constructing base maps.

While the drafting section reports to the Exploration department's vice-president, it handles work for nearly every other organization within the company. These projects include such varied chores as drawing floor plans for offices, drawing sub-surface cross sections; drawing charts and graphs, making mechanical drawings, handling oil unitization mapping and engineering map work, and performing all types of mapping for every Sunray Mid-Continent lease in which the company has participating interest.

Sunray lease data are placed daily on the 3000 land and pool maps by the Land group. About 21,000 Sunray leases have been checked in the last three years. This group also posts federal and state land sales, maintains records and posts farmouts and operating agreements, prepared land descriptions and special land plats.

Detailed information on oil, gas and water supply wells can be taken from the 3000 operating maps covering a land area from Florida to Canada with Texas included. This information is placed on the maps by the Development group. Draftsmen post about 1200 new wells each week and this information is used by all operating departments within the Tulsa office.

Plotting, posting, inking contours, posting acreage, making base maps and classifying all seismic and gravity maps are also daily duties of the Geophysical group. Members also maintain index maps showing the hundreds of prospects on which Sunray Mid-Continent has coverage.

This information is expensive and confidential and every caution is exercised to protect it.

With more than 5000 maps to file and check out, the File group's duties are clearly defined. Each map must be checked in and out carefully and the location of each map must be known at all times.

Serving the geologist, geophysicist, landman, engineer and various company officials, the group has to remember names of counties and leases in order to be able to place the information in the right hands without delay.

Sunray's draftsmen range in age from 19 to 52 and most of them have been trained in both high school courses and special drafting schools. All have received on-the-job training.

New development. Newest development in the drafting section is the facet map, a large map made up of small separate sections. If new information is sent in from the field, just a small rectangle of the huge map is changed.

The drafting section is able to place the latest information on maps immediately, thus permitting engineers, geologists, landmen, scouts and company officials to see cumulative data on the "big picture" scale in one easy glance.

Economy and speed were the major factors considered in adopting the facet map system. The department is prepared to give any new drafting development a long hard look and, if the operation is practical, to adopt it. * * *

a special service for fracturing and acidizing in a single operation

Geofrac is a clean-breaking gelled fracturing acid with virtually unlimited sand-carrying abilities. Solutions are available with either 15 per cent hydrochloric acid, recommended for limestone and dolomite formations, or 5 per cent for sand or other formations. Geofrac does not contain Batu gum, no gel-breakers or other solutions are necessary to clean up, no deposition is left in the well or the formation, and little or no shut-in time is necessary. Geofrac is exceptionally stable at high temperatures, the solution has a good viscosity, good gel properties, and virtually no fluid loss.

If you are not fully acquainted with our Geofrac Service, ask your nearest Chemical Process Company station for details or write us in Breckenridge, Texas; we will be glad to send you illustrated literature and other data without obligation.

Geofrac for Acidizing/Fracturing

THE CHEMICAL PROCESS CO
SERVICING OIL & GAS WELLS

THE CHEMICAL PROCESS COMPANY

General Offices in Breckenridge, Texas
Stations Throughout the Mid-Continent Area

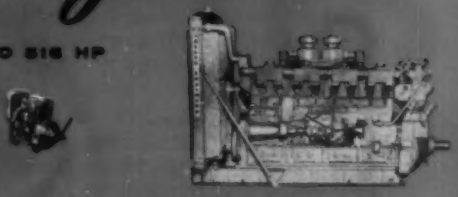
IT'S Allis-Chalmers ENGINES for *any* Power Need

any FUEL

DIESEL . . . GASOLINE
LP GAS . . . NATURAL GAS

any SIZE

9 TO 816 HP

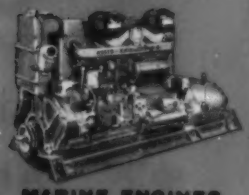


any TYPE

OPEN OR ENCLOSED POWER UNITS

GENERATOR SETS

FAN-TO-FLYWHEEL ENGINES



MARINE ENGINES

any USE

Make your Allis-Chalmers Engine Dealer your main source of power for all your engine needs. He can supply a wide range of engines for any fuel — gasoline, diesel, LP gas, natural gas — for any use . . . stationary or mobile-power units, fan-to-flywheel engines, generating sets or marine engines. Each has the high-efficiency, long-life characteristics necessary for continuous as well as stand-by service. With a high degree of interchangeability of parts, you can use a different type of engine for each application and yet maintain a small stock of parts.

Write for bulletins or see your Allis-Chalmers Engine Dealer for more information.

ALLIS-CHALMERS, BUDA DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

Nomographs quickly solve natural frequency of any straight or two-way tapered rod string.

Desirable Pumping Unit Speeds

Charles L. Coffman
Cities Service Oil Company
Bartlesville, Oklahoma

VIBRATION problems in oil wells were called to the attention of the oil industry in 1937 by J. C. Slonneger.[1] [2] He developed formulas and charts to determine pumping speeds in phase with the natural frequency of sucker rod strings. Although it was pointed out that these solutions were applicable only to straight rod strings, engineers generally have used this information to estimate synchronous speeds of tapered rod strings.

Slonneger also has derived a formula which can be used to accurately determine the frequency of *any* rod string. He found that the natural frequency of a rod string is inversely proportional to the square root of the static elongation. This formula is more difficult to use than the simple one for non-tapered strings; and, consequently, has found limited usage.

Nomographs have been prepared to simplify the use of this formula in accurately determining the natural frequency of tapered or non-tapered rod string. The nomograms were calculated for ⅞-in. and ¾-in. tapered strings. However, it was found that the graphs are correct for any two consecutive rod sizes: 1-in. and ⅞-in., ⅞-in. and ¾-in. and ¾-in. and ⅝-in. Therefore, the nomographs are applicable to any straight or two-way tapered rod strings, providing the tapered rod strings consist of no more than two sizes of rods and these two sizes of rods are consecutive sizes.

The frequency is readily determined

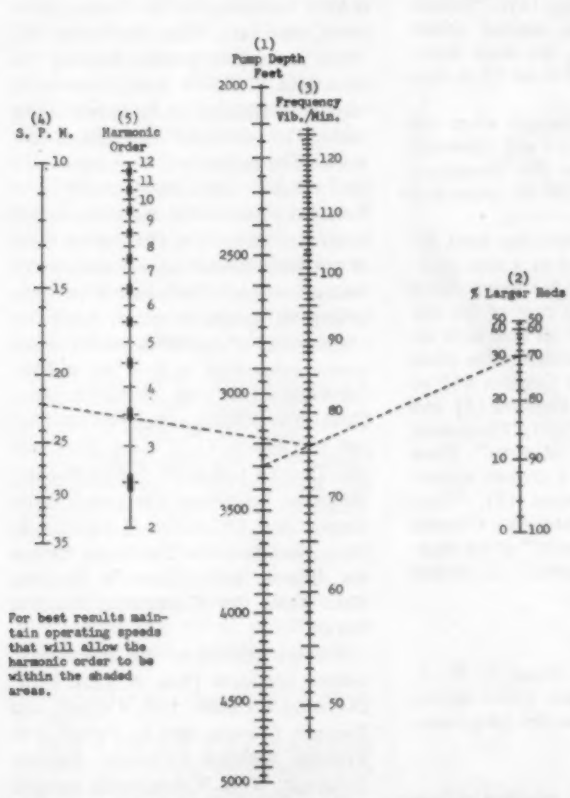


Fig. 1 — **For 2000 ft to 5000 ft** pump depths. Nomograph aids rapid determination of desirable operating speeds applicable to all straight or two-way tapered rod strings from 2000 to 5000 ft.

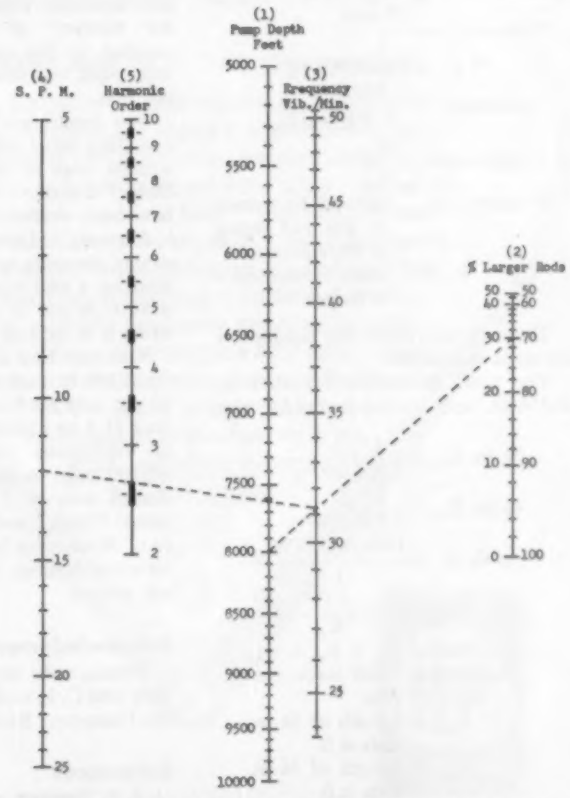


Fig. 2 — **For 5000 ft to 10,000 ft** pump depths. From this nomograph, desirable operating speeds can be determined for all straight or two-way tapered rod strings from 5000 ft to 10,000 ft.

from the nomographs. All the information that is necessary is the total length of the rod string and the per cent of the larger size rods. After the frequency has been determined, one more step will determine the order of harmonic motion. All the information that is necessary for this step is the frequency and the strokes per minute.

Derivation of Formulas:

$$\text{Frequency} = \frac{(15{,}800)\ (60)}{4L}$$

$$\therefore \text{Frequency} = \frac{237{,}000}{L}$$

(This is the simple formula applicable only to straight rod strings.)

Frequency = Natural frequency of a rod string in vibrations per min

15,800 = Speed of sound in steel in ft/sec.

60 = Constant to convert ft/sec to ft/min

4 = Constant used because all rod strings are ¼ wave length

L = Length of rod string in ft

A tapered rod string is computed as follows:

$$\text{Frequency} = \frac{237{,}000}{L}$$

$$^{(3)}\ L^2 = 1{,}320{,}000\ E_s$$

$$\therefore \text{Frequency} = \frac{237{,}000}{\sqrt{1{,}320{,}000\ E_s}}$$

$$\therefore \text{Frequency} = \frac{206}{\sqrt{E_s}}$$

Frequency = Natural frequency of any rod string in vibrations/min

E_s = Static elongation in inches

The only variable in this equation is the static elongation.

The static elongation for a ⅞-in. and ¾-in. taper is computed as follows:

$$\text{⅞-in. } E_{s1} = \frac{L^2_{7/8}}{1{,}320{,}000}$$

$$\text{¾-in. } E_{s2} = \frac{L^2_{3/4}}{1{,}320{,}000}$$

$$\text{⅞-in. } K_2 = \frac{(660{,}000)\ (W_{7/8})}{L_{7/8}}$$

$$E_{s3} = \frac{(L_{3/4})\ (W_{3/4})}{K_2}$$

$$\therefore E_s \text{ Total} = E_{s1} + E_{s2} + E_{s3}$$

E_s Total = Total static elongation

$L_{7/8}$ = Length of ⅞-in. rods in ft

$L_{3/4}$ = Length of ¾-in. rods in ft

K_2 = Static spring constant of the ⅞-in. rods in pounds/in.

$W_{7/8}$ = Wt of ⅞-in. rods in lb

$W_{3/4}$ = Wt of ¾-in. rods in lb

Nomographs shown in Fig. 1 and 2 were designed to solve these equations graphically. To be practical and fit the equations, Fig. 1 was designed to solve pumping unit speeds applicable to all straight or two-way tapered rod strings from 2000 to 5000 ft. Fig. 2 is used to determine desirable operating speeds applicable to all straight or two-way tapered rod strings from 5000 to 10,000 ft.

How to Use Nomographs

Example 1: Determine the desirable pumping unit speed on a well where the pump depth is 3300 ft and where 30 per cent of the rods are ⅞-in. and 70 per cent are ¾-in.

Solution: Referring to Fig. 1 (applicable to 2000 to 5000-ft depths) lay a straight edge from the 3300 point on Column (1), "Pump Depth in Ft," to Column (2), "Per Cent Larger Rods," and read 75.9 from Column (3), "Frequency in Vibrations Per Min." Pivot straight edge from this point so that it crosses Column (5), "Harmonic Order," in one of the nearest shaded areas and intersects Column (4), "Strokes Per Minute," at the nearest whole number. In this case, the most desirable speed was found to be 22 strokes per min.

Best results are obtained when the operating speed selected will allow the straight edge to cross the "Harmonic Order," Column (5), in the areas that have been shaded.

Example 2: Determine the most desirable pumping speed of a unit operating on a well where the pump depth is 8000 ft and 70 per cent of the rod string is ⅞-in. and 30 per cent is ¾-in.

Solution: Lay a straight edge from the 8000 ft mark on Column (1) to 70 per cent mark on Column (2) and read 31.2 on Column (3), "Frequency in Vibrations per Minute." Pivot straight edge so that it crosses nearest shaded area of Column (5), "Harmonic Order," and intersects Column (4), "Strokes per Minute," at the nearest whole number. Answer is 12 strokes per minute.

Acknowledgment

Nomographs were drawn by W. A. Dow and C. L. Coffman, Cities Service Oil Company, Bartlesville, Oklahoma.

References

1. J. C. Slonneger is a consulting engineer for The Continental Supply Company at Dallas, Texas.
2. "Vibration Problems in Oil Wells" by J. C. Slonneger, API Drilling and Production Practices, 1937.
3. "Graphic Methods of Analyzing Dynamometer Cards" by J. C. Slonneger, The Petroleum Engineer, Sept. 1936, pg. 155. ★ ★

1957 Officer Nominations Announced by AAPG

American Association of Petroleum Geologists has announced the following slate of officer nominations submitted by the organization's nominating committee: for president, Hollis D. Hedberg, Gulf Oil Corporation, Pittsburgh, Pennsylvania, and Graham B. Moody, consultant, Berkeley, California; for vice president, B. Warren Beebe, Keating Drilling Company, Oklahoma City, Oklahoma, and Grover E. Murray, Louisiana State University, Baton Rouge, Louisiana; for secretary treasurer, William J. Hilseweck, Blackwood and Nichols Company, Dallas, Texas; for editor, Sherman A. Wengerd, University of New Mexico, Albuquerque, New Mexico.

Meeting in Tulsa in July as chairman of the AAPG executive committee, President Theodore A. Link pointed out that additional nominations for any office may be made by submitting to AAPG headquarters in Tulsa, Oklahoma, not later than November 15, 1956., a written petition bearing the signatures of 50 or more association members. Election is by secret ballot mailed to members throughout the world. The ballots will be counted and the winners announced early next February. Successful candidates will take office on April 4, 1957, at the close of the forty-second annual meeting of the association, to be held in Kiel Auditorium, St. Louis, Missouri, April 1-4.

Chairman of the 1956 AAPG nominating committee is Roy M. Barnes, Continental Oil Company, Los Angeles, California. Other members include Carroll E. Dobbin, U. S. Geological Survey, Denver, Colorado; J. Eric Bucher, Magnolia Petroleum Company, Oklahoma City, Oklahoma; Laurence L. Sloss, Northwestern University, Evanston, Illinois, and William A. Thomas, The Ohio Oil Company, Houston Texas.

Present officers of the Association include president Theo. A. Link, Link, Downing & Cooke, Ltd., Calgary and Toronto, Canada; Ben H. Parker, The Frontier Refining Company, Denver, Colorado; W. A. Waldschmidt, consultant, Midland, Texas; W. C. Krumbein, Northwestern University, Evanston, Illinois, and G. M. Knebel, Standard Oil Company (New Jersey), New York City.

Shell, Conoco Launch 'Operation Neptune'

In a new venture 63 miles off the coast of Texas, a giant mobile platform is about to lower its drill bit to search for oil in 93 ft of water.

Until now, no well has ever been attempted more than 40 miles off Texas shores.

The drilling — "Operation Neptune" — was launched by Shell Oil Company after extensive preparations in the area known as the Neptune Block, leased from the federal government last July. Later Continental Oil Company took a half-interest in the block. The 103,000-acre block is the largest offshore block currently held by one company on the Texas or Louisiana continental shelf.

The $3,500,000 drilling barge, "Mr. Gus," has been contracted for the job from C. G. Glasscock Drilling Company of Corpus Christi.

One of the largest mobile offshore units, "Mr. Gus" is designed to operate in water depths of as much as 100 ft.

The vessel was towed to the drillsite which was staked after seismic work in the area. Hydraulic jacks forced four-foot-diameter piles into the ocean floor. The barge's lower hulls were then filled with water and sunk to safeguard the foundation and thus increase the unit's stability.

The mobile unit consists of two platforms. One, the submersible hull; the other which carries the drilling rig, a 35-ton crane, a smaller portable crane, air-conditioned quarters for 31 crew members and storage area. A helicopter landing base extends from the service platform.

All equipment is of heavy construction, capable of withstanding 40-ft waves and winds of 125 mph.

The drilling crew will be normally supplied by boat from Galveston. The helicopter landing platform permits flying of emergency supplies and personnel in nearly an hour. However, the distance is too great for routine, all-weather helicopter flying. Thus, transportation by ship will be standard with sailing time from Galveston about six hours.

The well is expected to drill to about 12,000 ft.

Even if the well is dry, the drilling will provide valuable stratigraphic data this far out on the continental shelf. Many geologists believe that the continental shelf — a sedimentary floor sloping under the Gulf for about 125 miles — could add substantially to the nation's oil reserves.

How Do the Pumps You're Using Measure Up With

Precision **HARBISON-FISCHER ROD PUMPS**

("BEST PUMPS IN THE OIL PATCH")

Tough, non-galling one-piece seamless steel barrel tube... machine-straightened and finished to a perfect inside working surface • Hardened, corrosion-resistant one-piece sectional plunger... permanently and perfectly aligned at the factory and accurately ground and polished to a mirror finish • Manufacturing tolerance of .0005" for these two vital working parts • Heavy-duty models... with an extra-rigid, double-thick barrel tube that won't flex or breathe in deep-well pumping • Stroke-thru models... with barrel extensions for pumping mineral solids, scale, gyp, or paraffin • Interchangeable A.P.I. parts...always available at leading stores throughout the Oil Patch • Backed by one of the largest sub-surface pump manufacturers in the world...whose only business is oil well pumping equipment.

H·F
OIL WELL PUMPS

HARBISON-FISCHER MFG. CO. • *Fort Worth*

Representatives in All Major Producing Areas

FOR LONGER PUMP LIFE AND LOW MAINTENANCE

D+B

PRECISION-BUILT

PUMPS

are backed by

50 years of experience

Exclusive!

VALVE ROD LOCK NUT PREVENTS BREAKAGE OF VALVE ROD AND ELIMINATES UNSCREWING!

Lower lock nut also prevents valve rod breakage and allows a means of removing pump with the rod string.

50 Years of Dependability

For more than half a century, D+B Pumps have met and satisfied the most exacting requirements of oil operators everywhere.

Proven Design

Advanced design, backed by constant research and improvement, has been tested and proven under every possible condition in the oil fields of the world.

Better Fit and Performance

Precision manufacture by expert workmen using the best materials insures better fit and superior performance.

Pump Shop and Field Service

Expert service when you need it is available on a 24-hour basis from Continental Supply and D+B Pump Shops and field men in production areas. For information and bulletins, call your nearest Continental or D+B store.

CONTINENTAL

Serving the Oil and Gas Industries

CONTINENTAL SUPPLY COMPANY

A Division of The Youngstown Sheet and Tube Company

General Offices: Dallas, Texas

Representatives in all principal oil fields of the world

D+B • DEEP WELL PUMPS • SUCKER RODS • COUPLINGS

QUALITY OIL FIELD PRODUCT

EMSCO TRADE MARK

D+B DIVISION

EMSCO MANUFACTURING COMPANY

Garland, Tex. • LOS ANGELES, CALIF. • Houston, Tex.

General Sales Offices: Dallas, Texas

Down-Hole Chambers Increase Gas-Lift Efficiency

H. W. Winkler and
Camco, Inc., Houston, Texas
George F. Camp
Rainbo Sales, Inc., Oklahoma City, Oklahoma

Part 2 (Conclusion) — Additional chamber installations, consideration and sample calculations; chamber design considerations and actual field data on chambers

Two-Packer Chamber Installation. The operator is faced with two annular-volume-to-tubing ratios in the design of a two-packer chamber installation with the upper packer in the casing and the lower packer in a liner. It differs from the previous classification in that the upper volume is greater than the lower volume. A combination casing-liner annulus chamber is particularly applicable in low fluid level wells with several hundred feet of shot hole. An insert chamber should not be used because of the hazard of pulling operations in such an open hole. A schematic of this installation is shown in Fig. 9. The upper packer in the casing eliminates injection gas pressure against the liner pack-off except during gas injection cycles. Depth of the liner seat and the proposed depth of the upper packer must be known before designing this chamber installation.

Example 6: Two-packer chamber installation in which the upper packer is in the casing and the lower packer must be located in the liner with the maximum working fluid level not exceeding the top of the chamber:

Well Data: Total depth = 6400 ft; 7-in. OD 23 lb casing set at 5900 ft; 5½-in. OD 14 lb liner from 5840 ft to 6350 ft; 2½-in. tubing and dip tube; set top packer at 5800 ft (O.S.L. = 40 ft); injection gas pressure = 800 psig; static fluid gradient = 0.35 psi/ft (all oil), and wellhead tubing pressure = 40 psig.

$$\text{C.L.} = \frac{(P_1 - P_w) - \text{O.S.L.}\,(R - R_L)\,\text{S.G.}}{\text{S.G.}\,(R_L + 1)} \quad \text{(Equation 6)}$$

$$\text{C.L.} = \frac{(800 - 40) - 40\,(5.43 - 2.84)\,0.35}{0.35\,(2.84 + 1)} = 538 \text{ ft chamber}$$

Where:

$$R = \frac{V_{c\text{-}a}}{V_t} = \frac{31.4 \text{ bbl/1000 ft}}{5.79 \text{ bbl/1000 ft}} = 5.43$$

$$R_L = \frac{V_{t\text{-}a}}{V_t} = \frac{16.4 \text{ bbl/1000 ft}}{5.79 \text{ bbl/1000 ft}} = 2.84$$

Check:

$$H = \frac{P_1 - P_w}{\text{S.G.}} = \frac{800 - 40}{0.35} = 2170 \text{ ft Maximum head}$$

$$H = \text{O.S.L.}\,(R) + (\text{C.L.} - \text{O.S.L.})\,R_L + \text{C.L.}$$

$$2170 \text{ ft} = 40 \text{ ft}\,(5.43) + (538 \text{ ft} - 40 \text{ ft})\,2.84 + 538 \text{ ft} = 2170 \text{ ft}$$

Equation 6 is based on the assumption that the maximum working fluid level between gas injection builds up only to the level of the top packer.

Example 7: Two-packer chamber installation using the same well data as in Example 6 with the upper packer in the casing, the lower packer in the liner and a maximum producing bottom hole pressure of 600 psig.

$$\text{Maximum working fluid height} = \frac{P_f - P_w}{\text{S.G.}} = \frac{600 - 40}{0.35} = 1600 \text{ ft}$$

Maximum working fluid level above the upper packer, F.L.T.

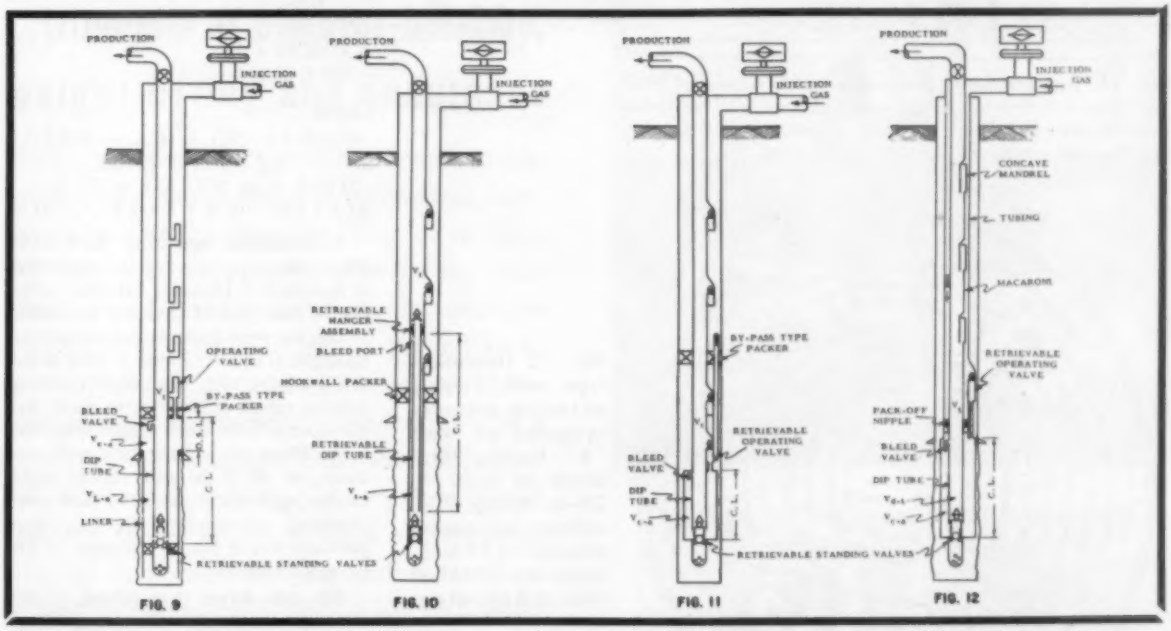


FIG. 9. **Casing-liner chamber** installation using two packers where both casing and liner annulus serve as the chamber.

FIG. 10. **Retrievable dip tube** installation where tubing serves as chamber. Point of gas injection can be lowered without pulling tubing.

FIG. 11. **For long perforated interval,** this insert chamber installation permits point of gas injection near total depth.

FIG. 12. **For bad casing,** this insert chamber installation incorporates a retrievable operating valve. Other valves removed with macaroni string.

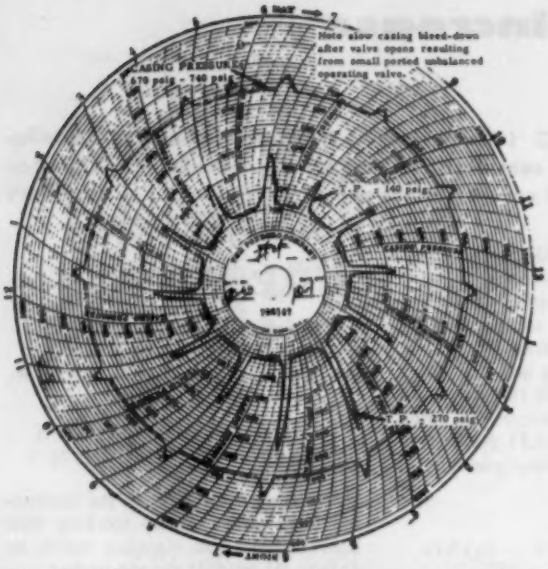

Note slow casing bleed-down after valve opens resulting from small ported unbalanced operating valve.
CASING PRESSURE
670 psig - 740 psig
T.P. = 140 psig
T.P. = 270 psig

FIG. 13. **Advantages of chambers** over conventional gas lift is shown above on this two-pen chart taken from a low-bottom hole pressure well in Louisiana. Depth: 10,260 ft, 2½-in. tubing, 7-in. casing. Producing 53 bbl fluid daily; 4.4 bbl oil per cycle.

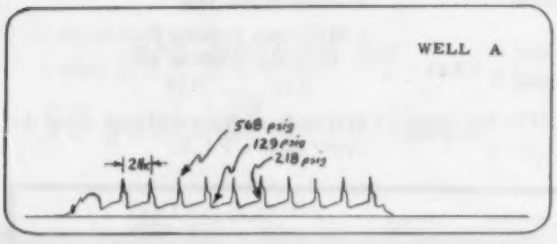


FIG. 15. **Bottom-hole pressure** bomb survey of Well "A" (Fig. 14) showing pressure versus time with bomb inside the chamber. There were 12 injection cycles per day and the well produced 3.5 bbl oil per cycle.

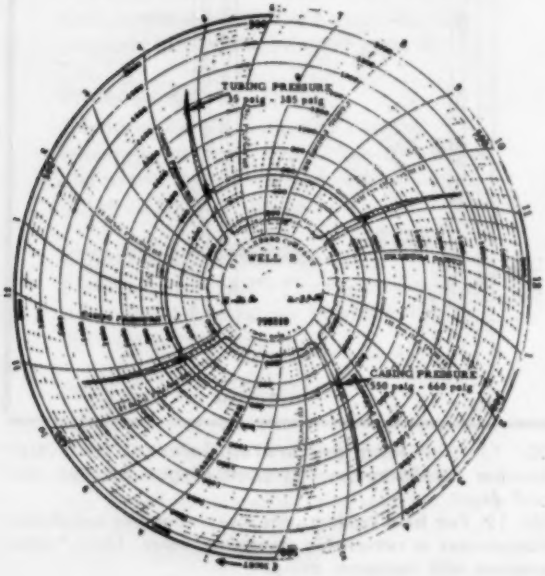


FIG. 16 Depletion type well. Tubing and casing pressures recorded on well "B" having total depth of 6700 ft, 2½-in. tubing, 7-in. casing, two-packer chamber 233 ft long, producing 24 bbl oil daily at 6 bbl oil per cycle.

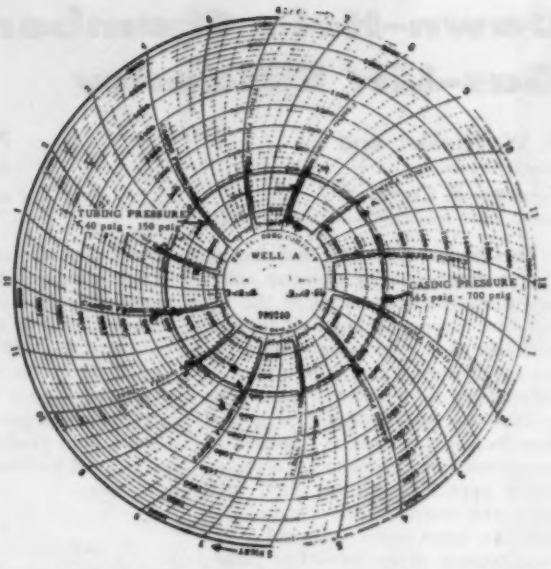


FIG. 14. **Pressure recordings** on tubing and casing taken on Well "A." Total depth: 6750 ft; 2-in. tubing; 5½-in. casing; 2-packer chamber 343 ft long; producing 42 bbl fluid daily; 3.5 bbl oil per cycle.

$$\text{F.L.T.} = 5800 \text{ ft} - (6400 \text{ ft} - 1600 \text{ ft}) = 1000 \text{ ft}$$

$$\text{C.L.} = \frac{(P_i - P_w) - [\text{O.S.L.}\ (R - R_L) + \text{F.L.T.}]\ \text{S.G.}}{\text{S.G.}\ (R_L + 1)} \qquad \text{Equation 7)}$$

$$\text{C.L.} = \frac{(800 - 40) - [40\ (5.43 - 2.84) + 1000]0.35}{0.35\ (2.84 + 1)} = 278 \text{ ft chamber}$$

Check:

$$H = \text{O.S.L.}\ (R) + (\text{C.L.} - \text{O.S.L.})\ R_L + \text{C.L.} + \text{F.L.T.}$$

$$2170 \text{ ft} = 40 \text{ ft}\ (5.43) + 278 \text{ ft} - 40 \text{ ft})\ 2.84 + 278 + 1000 \text{ ft} = 2170 \text{ ft}$$

A maximum operating fluid level above the upper packer is considered in Equation 7. Distance between packers for this type of chamber is critical as can be seen from a comparison of Example 6 with Example 7. This is the result of the high chamber to tubing volume ratios. It is better to make the chamber a little small rather than too large. These designs are for a well producing all oil. If the wells should begin producing water without the fluid level changing appreciably, the injection pressure would not be adequate to lift from the chamber.

Dip tube larger than tubing. If the dip tube is larger than the tubing string, the maximum head occurs at the instant fluid leaves the dip tube and gas enters the tubing. Total volume of the chamber and dip tube must be calculated, and this volume converted into feet of head in the small tubing string.

The rugged acrobats of the oil fields

EMSCO PUMPING UNITS

...triumphs of counter-balance, weight lifting and endurance

Throughout the oil producing areas of the world, you'll find dependable, economical, easy-to-adjust EMSCO Pumping Units doing their job, day after day, month after month, year after year. Due to patented, rotary counter-weights, one man, working at ground level, can quickly, safely and easily adjust them. Precision-cut herringbone gears mounted on a rigid one-piece housing with an automatic positive lubrication system spell long service and economy. There are many sizes and styles of EMSCO Pumping Units for shallow, medium or deep pumping. Call CONTINENTAL today for bulletins and complete details.

EMSCO

REG. U. S. PAT. OFF.

EMSCO MANUFACTURING COMPANY
Garland, Tex. • LOS ANGELES, CALIF. • Houston, Tex.
General Sales Offices: Dallas, Texas

CONTINENTAL

Serving the Oil and Gas Industries

CONTINENTAL SUPPLY COMPANY
A Division of The Youngstown Sheet and Tube Company
General Offices: Dallas, Texas
Representatives in all principal oil fields of the world

PT-602

Announcing.

Available Through the Leading Mud Companies

BAROID

TRIMULSO

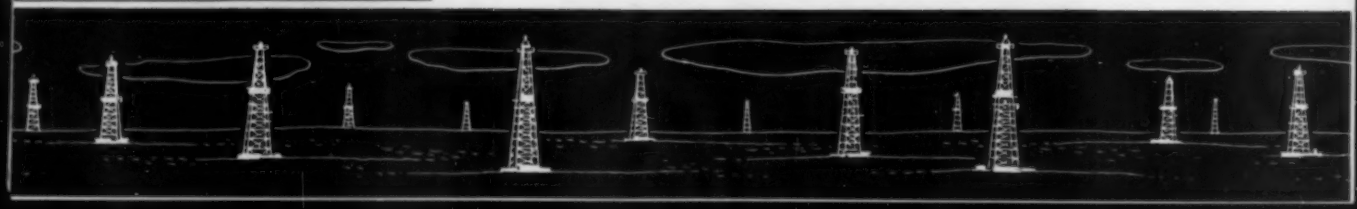
Magcobar
Complete
DRILLING MUD SERVICE

Drilling Milk

LUMUL

The high speed drilling fluid emulsifiers are available from the leading mud companies . . . Baroid, Magcobar and Macco . . . under their labels. These companies can provide complete information on the proper use and handling of these drilling fluid emulsions. Their knowledge and experience stand behind the application and use of these materials, and their extensive dealer organizations make the emulsifiers readily available.

Look for this seal ▸



..new drilling fluids

Synthetic chemical emulsifiers make low solids, oil-in-water emulsions for high speed drilling. Make better and safer hole while reducing drilling costs 6 ways·

- ★ Increased Penetration Rates
- ★ Reduced Torque
- ★ Increased Cuttings Size
- ★ Longer Bit Life
- ★ Reduced Corrosion
- ★ Easier Mud Control

Field tested and proven

These new drilling fluid emulsions, containing Aquaness emulsifiers, were developed by a leading drilling contractor in his search for ways to improve the drilling properties of clear water. In over 100 wells drilled in the Permian Basin, the following observations were made:

> Penetration rates and bit life are remarkably increased. The emulsifier maintains an oil film on the bearings and drill pipe, reducing bearing failures and providing substantial corrosion protection. Low specific gravity solids are dropped out, avoiding viscosity and weight build up. Cutting size is improved. Torque is greatly reduced.

Look for the Aquaness Seal when you buy the new high speed drilling fluid emulsifiers that were created and manufactured by Aquaness and thoroughly field tested by a leading drilling contractor. It's your assurance of uniform, highest quality, top performing, high speed drilling fluid emulsifiers.

For further information write to Magcobar about their "Drilling Milk," Baroid about their TRIMULSO or Macco about their LUMUL . . . or contact their nearest distributor.

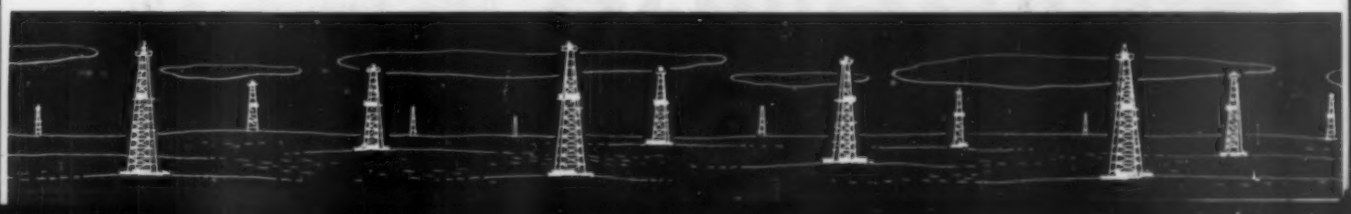
ATLAS

Aquaness Department

ATLAS POWDER COMPANY

2005 Quitman Street, Houston 26, Texas

The Aquaness Seal is your assurance of uniform, top quality products.



The insert chamber for bad casing in Fig. 12, is an example in which the dip tube could be larger than the macaroni string.

Example 8: Insert chamber installation for the same well data as in Example 4, except a 2-in. dip tube and 1-in. macaroni string are used with the equipment run as shown in Fig. 12.

$$C.L. = \frac{(P_i - P_w)\,V_t}{S.G.\,(V_{d\text{-}t} + V_{c\text{-}a})} \quad \text{(Equation 8)}$$

$$C.L. = \frac{(650 - 50)\,1.07}{0.45\,(3.87 + 6.7)} = 135 \text{ ft chamber}$$

Where:

$V_t = 1.07$ bbl/1000 ft
$V_{c\text{-}a} = 6.7$ bbl/1000 ft
$V_{d\text{-}t} = 3.87$ bbl/1000 f.

Check:

$$(H(V_t) = C.L.(V_{d\text{-}t}) + C.L.(V_{c\text{-}a})$$

$$1333 \text{ ft} = \frac{135 \text{ ft}\,(3.87) + 135 \text{ ft}(6.7)}{1.07} = 1333 \text{ ft}$$

Equation 8 is based on the assumption that the working fluid level does not exceed the top of the chamber. A limited reservoir feed-in represents a sizeable fluid head build-up in small tubing. Therefore, the maximum possible working fluid level must be considered in this type of chamber.

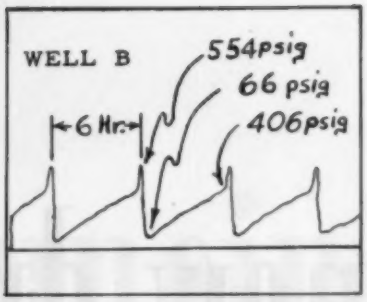


FIG. 17. **Bottom-hole pressure bomb survey of Well "B" (Fog. 16) showing pressure versus time with bomb inside chamber. There were 4 injection cycles daily, well producing 6 bbl oil per cycle.**

Example 9: Insert chamber installation for the same well data as in Example 8, except the maximum producing fluid level is 500 ft above the top of the chamber (F.L.T. = 500 ft).

$$C.L. = \frac{[\,(P_i - P_w) - F.L.T.\,(S.G.)\,]\,V_t}{S.G.\,(V_{d\text{-}t}) + V_{c\text{-}a}} \quad \text{(Equation 9)}$$

$$C.L. = \frac{[\,(650 - 50) - 500\,(0.45)\,]\,1.07}{0.45\,(3.87 + 6.7)} = 84 \text{ ft chamber}$$

Check:

$$(H(V_t = C.L.\,(C_{d\text{-}t}) + C.L.\,(V_{c\text{-}a}) + F.L.T.\,(V_t)$$

$$1333 \text{ ft} = \frac{84 \text{ ft}\,(3.87) + 84 \text{ ft}\,(6.7)}{1.07} + 500 = 1333 \text{ ft}$$

Chamber Design Considerations

A chamber should always be designed to permit gas injection through the operating valve only. The point of gas injection of the operating valve is at the bottom of the dip tube and not the point at which the valve is actually located on the tubing string. The unloading valve immediately above the operating valve may in some instances be run only a joint above the operating valve. This unloading valve is located near the operating valve to assure unloading the chamber. It is advisable for the closing pressure of the operating valve to be at least 50 psi lower than the closing pressure of the above unloading valve. This prevents opening the unloading valve while lifting from the chamber.

Volume of dip tube. The dip tube and chamber fill to the same level if the bleed port is adequate. The dip tube is full when injection gas first enters the chamber and is still full at the instant gas enters the tubing string

ROCKFORD

Clutches Are Spin Strength Tested to Meet The Needs of Modern High Speed Engines

First they are put in a deep, armor-plated, concrete test pit.

Then fastened on a shaft that spins the clutch at high speed.

The clutch is spun, and highest R.P.M. recorded.

Let us help insure fully-tested clutches for YOUR products.

ROCKFORD
Clutch Division
BORG-WARNER
1303 Eighteenth Ave., Rockford, Ill.

CLUTCHES

Pumping their way to Leadership

ALTEN PUMPING UNITS

Thousands of ALTEN Units—operating for years with low, low cost records —*Are Pumping Their Way to Leadership*. Put them to work for you!

Available in all sizes: small beam balanced, beam and crank balanced, or medium and large types with the ALTEN screw-type adjustable counter balance. You can be sure of peak performance with every model in each series.

Ask your independent supply store or write ALTEN for latest catalogue and engineering information.

✓ **A FULL LINE OF 47 MODELS AND TYPES**

✓ **WORLDWIDE DISTRIBUTION THROUGH SUPPLY STORES**

-ALTEN-
Foundry & Machine Works, Inc.
LANCASTER, OHIO

through the dip tube. Back pressure from the head of fluid, regardless of the size dip tube, is only a function of its length and not its volume.

The dip tube should be as near the tubing ID as possible to provide a maximum slug volume per foot of head and to reduce turbulence and gas breakthrough when the fluid slug passes from a small dip tube to the larger tubing. In addition, a large dip tube permits using a retrievable standing valve and running pressure bomb surveys.

Injection gas pressure. To compensate for the pressure loss through the operating valve, by-pass packer, crossover, etc., the design injection gas pressure available inside the chamber should be considered equal to or less than the surface closing pressure of the unloading valve immediately above the operating valve. Gas weight in the casing annulus and the difference between the opening and closing pressure of the unloading valve will offset the pressure loss in most instances.

Bleed Ports. Size of bleed port near the top of the chamber is not a problem in wells producing little formation gas. Function of this bleed port is to remove the formation gas to permit the chamber to fill with liquid rather than gas. A 25 psi differential valve with small orifices or a 3/32-in. hole generally is used in low gas producing wells. Advantage of the differential valve is that it will close when the operating valve opens, thus preventing a gas cut slug. A high gas-fluid ratio well must have the bleed port properly sized. This port should be adequate to pass formation gas during the fill-in time between cycles.

Valve spread. The difference between the opening and closing pressures of a pressure operated flow valve, commonly referred to as valve "spread", is important in chamber design. Opening pressure of a pressure operated valve is reduced by back pressure in the tubing opposite the valve, but the closing pressure remains constant. The higher the tubing pressure opposite the valve, the lower the valve spread. In most chamber installations, the pressure in the tubing opposite the operating valve is the wellhead tubing pressure plus a few pounds of gas weight.

The valve spread can be prohibitive if a partially balanced type valve is not used. The balancing mechanism built into the valve reduces its spread characteristics, but retains a large port size. The operator can select the valve spread to meet his gas requirements. The spread required decreases as the size of the casing annulus increases.

Chamber size. Top of the chamber should not be located above the maximum working fluid level of the well. An excessive chamber length will result in excessive injection gas-fluid ratios, if it does not completely fill. The chamber must be completely filled with high pressure injection gas before the gas enters the tubing and lifts the slug to the surface. The injection gas bleeddown time for a chamber that is too long reduces the number of injection gas cycles per day; therefore, the producing capacity of a high productivity, extremely low bottom-hole pressure well is reduced. In many wells, daily production has been increased by lowering the opening pressure of the operating valve when the chamber is not filling.

Packers. When a two-packer chamber installation is contemplated, a hookwall or production type packer can be used on bottom with a pin or cup type packer on top. If a hookwall packer is used as the upper packer, a cup type packer is generally employed as the lower packer. The casing should always be scraped prior to running a cup packer. Cup packers set at great depths are frequently damaged during the running operations. When the cup packer is to be set in a liner, centralizers can be used to prevent the cups from dragging against the casing walls while being run in the hole.

Wire line equipment. Retrievable gas lift equipment offers the operator maximum efficiency with minimum loss of production. Wells in a closed type reservoir will have low producing bottom-hole pressures at time of abandonment. A chamber can be run initially in these wells to permit depletion without pulling the tubing. Retrievable valves can be reset to produce efficiently the wells during changing conditions of flush, twilight, and depletion stages. Large savings are realized by eliminating costly tubing jobs and packer repairs.

Actual Field Data

Two thousand-foot wells with bottom-hole pressures of only 20 psig are being depleted in Peru by gas lift with chambers. These wells, which date back to World War I, are producing more fluid by gas lift than by the previous producing methods. And, the number of operating personnel has been drastically reduced with installation of gas lift equipment.

Deep wells in California with low bottom-hole pressures are being suc-

Example 1: Depletion Production.

Well A Data: Total depth = 6750 ft; 2-in. tubing; 5½-in. OD casing.

Equipment	Date of Test	Production (BOPD)	Gas-Oil Ratio (Cu ft/bbl)
Positive displacement pump	2- 1-56	34	1954-producing
Gas lift chamber	2-27-56	42	1257-injection

Fig. 14 and 15 are the two-pen surface pressure recorder and actual bottom-hole pressure charts of a typical test run on the above well.

Well B Data: Total Depth = 6700 ft; 2½-in. tubing; 7-in. OD casing.

This chamber installation is producing 24 BOPD with a minimum producing bottom-hole pressure of 66 psig. Fig. 16 is a two-pen surface pressure recorder chart, and Fig. 17 is an actual bottom-hole pressure chart of this depletion type well.

Example 2. Intermediate Production.

Well C Data: Total depth = 6750 ft; 2-in. tubing; 5½-in. OD casing.

Equipment	Date of Test	Production Oil (BPD)	Water (BPD)	Total (BPD)	Injection Gas-Oil Ratio (cu. ft/bbl)
Positive displacement pump	1-29-56	61	40	101	——
Gas lift chamber	2-29-56	86	39	125	1179

Note: During positive displacement pump test the well was equipped with 2½-in. tubing.

Example 3. Chamber versus Natural Flow.

Well D Data: Total depth = 6750 ft; 2½-in. tubing; 7-in. OD casing.

Equipment	Date of Test	Production (BOPD)	Injection Gas-Oil Ratio (cu ft/bbl)
Natural flow	4-15-55	149	——
Gas lift chamber	11-15-55	185	1909

Well E Data: Total depth = 6750 ft; 2-in. tubing; 5½-in. OD casing.

Equipment	Date of Test	Production (BOPD)	Injection Gas-Oil Ratio (cu ft/bbl)
Natural flow	8-20-55	126	——
Gas lift chamber	12-26-55	164	2537

All the above production data represent as nearly as possible stabilized well conditions.

Prevent Casing Failures

SPECIFY and USE

McEvoy "Controlled Friction" Casing Hangers

Your well investment is no safer than the Well Head Equipment and Casing Hangers which support your casing strings. Like good insurance in a safe, sound company, good Casing Hangers dependably protect your investment every minute of the day and night. They work for you without attention or care for years and years . . . for the entire life of your wells. Your wells deserve the best, most reliable, and in the long run, the cheapest . . . McEvoy's unique, exclusive and unrivaled "Controlled Friction" (CF) Casing Hangers. Easily recovered, completely salvageable.

The only Engineered Hangers with Capacity Curves available—write for details and data . . . then compare!

A set of McEvoy new revolutionary "CF" Slips, showing both inner (sharp) and outer (dull) teeth. You can see that these outer teeth are not merely "rough machined", but are actual precision-made teeth that controllably engage the slip-bowl.

Sectional view showing McEvoy "CF" Slips, with sharp teeth on one side securely supporting the casing, and dull teeth on other side which control the slip-bowl friction, and automatically limit the downward movement of the slips in their bowl.

Casing pressures, test pressures, or high pressure remedial work cannot load the slips or change their pipe load capacity. Hydraulic and mechanical loads are completely separated.

Available for all wells

FOR THE WORLD'S DEEPEST WELLS

McEvoy SB-2 Casing Hangers were developed through extensive research, and have proved the complete answer to every deep, high pressure, heavy string need. May be wrapped around the pipe and dropped through the preventers, automatically **set** and **seal,** providing the ultimate in safety. Will safely support **any casing string that can be picked up in the derrick.**

FOR MEDIUM DEPTH WELLS

McEvoy Type CB or CB-2 Casing Hangers were designed and are fully field proven for handling all medium and medium-heavy casing strings in complete safety to the full strength of short thread API couplings. They satisfy a long felt user need for simple, functional and dependable lower cost casing hanging equipment.

McEvoy "CF" Hangers have been proven and demonstrated . . . Let us show you.

McEvoy COMPANY

OIL WELL EQUIPMENT

TEXAS AND MILBY ST. • P. O. BOX 3127 HOUSTON 1, TEXAS

Pipe Line Microwave Systems

presented by

THE Petrol Engin

P. O. Box 1589

Map No. 2 (Replaces Map No. 1, dated May, 1956)

LEGEND

Systems operating in the 960 mc band .....
Systems operating in the 2000 mc band ——
Systems operating in the 6000 mc band - - - -

KEY

1. American Oil Pipe Line Company
2. Atlantic Seaboard Corporation
3. Buffalo Pipe Line
4. Colorado Interstate Gas Company
5. El Paso Natural Gas Company
6. Humble Pipe Line Company
7. Industrial Supply Corporation
8. Interstate Petroleum Communications, Inc. (Shell Pipe Line)
9. Atlantic-Sinclair System
10. Michigan Wisconsin Pipe Line Co.
11. Mid-Valley Pipe Line Company
12. Natural Gas Pipe Line Company of America
13. Natural Gas Storage Company of America
14. New York State Natural Gas Corporation
15. Ohio Oil Company
16. Oklahoma Mississippi River Products Pipe Line Corporation
17. Oklahoma Natural Gas Company
18. Panhandle Eastern Pipe Line Co.
19. Plantation Pipe Line Co.
20. Platt
21. Richf
22. Salt
23. Servi
24. Sincl
25. Sincl
26. Gene
27. Stan (Proc
28. Sun
29. Tenn
30. The

etroleum
gineer

Dallas 21, Texas

Published as a supplement to
August 1956 Issue
The Pipeline Engineer

20. Platte Pipe Line Company
21. Richfield Oil Company
22. Salt Lake Pipe Line Company
23. Service Pipe Line Company
24. Sinclair-Continental System
25. Sinclair-Pure System
26. General Petroleum Corporation
27. Standard Oil Company of Indiana (Products Pipe Line Dept.)
28. Sun Pipe Line Company
29. Tennessee Gas Transmission Co.
30. The Texas Company
31. Texas Eastern Transmission Corp.
32. Texas Gas Transmission Corp.
33. Texas Illinois Natural Gas Pipe Line Company
34. Transcontinental Gas Pipe Line Corporation
35. Trunkline Gas Company
36. United Gas
37. Union Oil Company
38. Wilcox Trend Gathering System, Incorporated
39. Sinclair Pipe Line Company

THIS NEW KIND OF....

.....SEALING RING MAKES.....

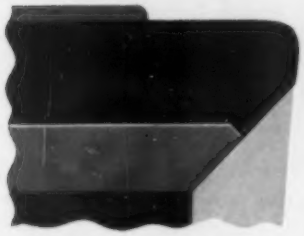
.....MISSION.....

....MUD MONARCH.....

....VALVES....

LAST LONGER

CONVENTIONAL



Conventional valves use a sealing element that seals at an angle, usually in the same plane with at least part of the striking surface. This arrangement works well when the valve is new and when pump pressures are low.

With wear, however, an opening forms at the junction of valve body, seat and sealing element. High pump pressures force part of the rubber sealing element into this space and it is pinched off. The result is short life for both sealing element and valve.

MISSION MUD MONARCH

NEW

With Mud Monarch Valves, the valve body strikes against the entire inclined surface of the valve seat, and the near-vertical seal ring seals against the outside diameter of the valve body. With this design, seal ring life is independent of valve and seat wear.

OLD

With wear, the entire inclined striking surface of the seat is worn away. An opening can't form next to the seal ring. Both valve and seat wear longer before they need be replaced and seal ring life is increased substantially—

HERE'S WHY MUD MONARCH VALVES LAST LONGER THAN CONVENTIONAL VALVES UNDER JET DRILLING CONDITIONS

Most slush pump valves do a good job when they are new, but when valve body and seat become worn, an opening forms between seat and body next to the sealing element that plays havoc with valve life. This condition exists, to a certain degree, with all valves except the Mud Monarch. By preventing the formation of this opening, Mission Engineers have developed a valve that gives truly outstanding service – especially in high pressure jet drilling where most valves fail rapidly. If you are dissatisfied with the service you are getting from slush pump valves, try the Mission Mud Monarch. You will discover a new high in valve performance and a new low in valve costs. Like all Mission Products, Mud Monarch valves are guaranteed to give outstanding service or your money is refunded. You can't lose, so try them right away. They are made in sizes to fit most pumps and are available through all supply stores.

Mission Mud Monarch Valve

Nothing but the finest will bear the name of MISSION MANUFACTURING CO.

MISSION MANUFACTURING CO. • P. O. Box 4209 • Houston, Texas • Cable Address–"Missco" • Export Office: 30 Rockefeller Plaza, New York
In England: MISSION MANUFACTURING CO., LTD. • 17 Hanover Square • London, W.1. England • Cable Address–"Missoman"

Now...load rate your bearings at higher values

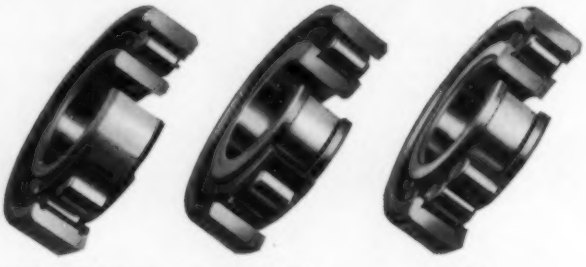
with Tru-Rol CROWNED ROLLERS

Greater capacity . . . longer life . . . or a precisely balanced gain of *both* factors. That is the choice offered you by the "crowned" rollers of Tru-Rol bearings.

By finish grinding a carefully selected crown radius on roller ends, Rollway relieves high stress areas, insures uniform distribution of load over the entire length of the roller. Rollers can take heavier loads without excessive end-fatigue, and are less subject to the effect of slight misalignment or deflection.

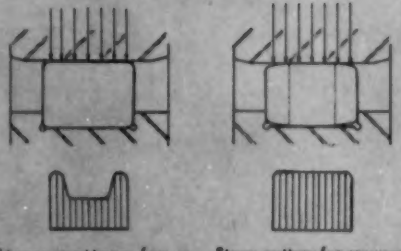
The result is load rating at higher values for greater capacity, longer service life . . . or both. If this choice interests you, why not write for the complete story. Rollway Bearing Co., Inc., Syracuse, N. Y.

Tru-Rol Bearings with crowned rollers are available in 3 types



Stamped Steel Retainer with Guide Lips | Segmented Steel Retainer | Full Roller

Comparative Stress Patterns under Uniform Loads for Straight and Crowned Cylindrical Rollers



Stress pattern for a straight cylindrical roller under load. Note uneven end-loading.

Stress pattern for crowned roller under load. Crowning radius is exaggerated for clarity.

● Rollway engineering service is available to help you select exactly the right bearings for your needs. Write us.

ROLLWAY BEARINGS

COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

ROLLWAY REPLACEMENT BEARINGS are available through authorized distributors in principal cities. Consult the yellow pages of your telephone directory — under "Bearings".

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Milwaukee • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

cessfully produced by gas lift using chambers. These wells range in depth from 8000 to 10,500 ft with producing bottom-hole pressures as low as 300 psig. These wells have a gross producing rate equal to or greater than before the chambers were installed, with a reduction in lifting costs of 40 to 60 per cent.

Chamber installations currently are being run in Oklahoma in wells ranging in depth from 6000 ft to 10,200 ft. Their successful operation has resulted in the replacement of other methods of artificial lift with chamber installations.

Many gas lift wells are being converted to chamber installations with resulting increase in production and efficiency. A 10,620 ft low bottom-hole pressure well in Louisiana in which a chamber was run illustrates the advantages of a chamber over conventional gas lift. The well was producing 36 bbl of fluid per day for five months prior to installing a chamber. The well has produced 53 bbl of fluid per day for the four months following the chamber installation, with a very noted reduction in gas-fluid ratios. Fig. 13 is a two-pen surface pressure recorder chart of this well.

Well tests. The following group of tests emphasizes the flexibility of chamber design and illustrates the gas lift chamber advantages.

Some Aspects of Accumulation Chambers

Advantages of a properly designed chamber can be summarized as follows:

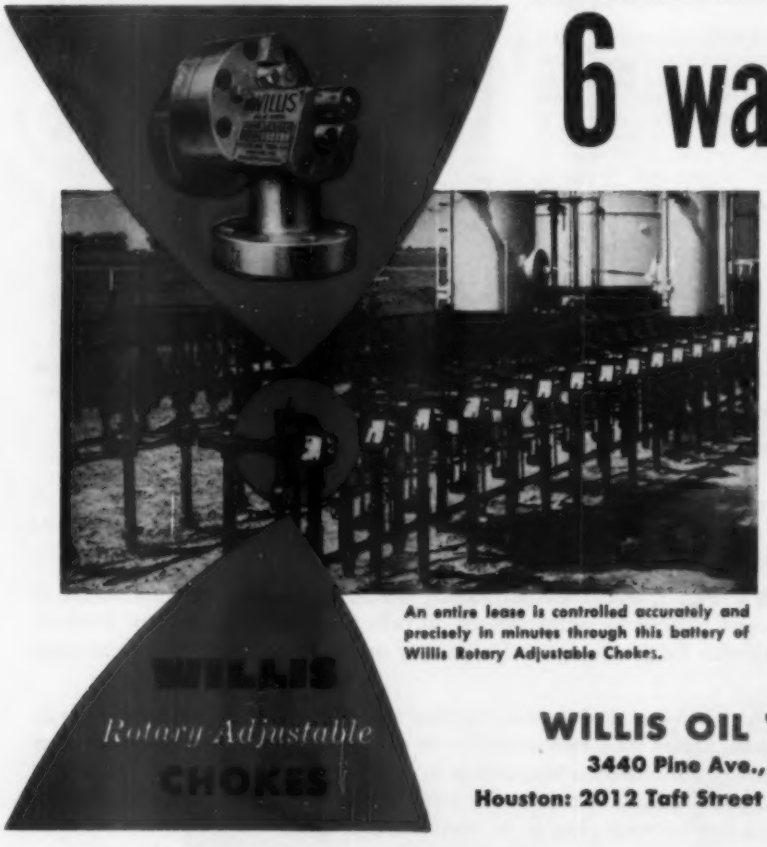
1. The equipment and operating costs for gas lifting stripper wells are low.
2. Ultimate depletion of low bottom hole pressure wells is possible.
3. The point of gas injection can be located near total depth in wells with several hundred feet of perforations or open hole.
4. Minimum gas break-through is assured.
5. Maximum fluid recovery is obtained with a minimum fluid head build-up against the formation.
6. Daily production can be increased.
7. The required injection gas-fluid ratio is reduced.
8. A lower average producing bottom hole pressure is assured.

Data needed. Information required to calculate the correct chamber length is:

1. The effective injection gas pressure available inside the chamber and the wellhead tubing back pressure are required.
2. The ratio of the volume of the chamber annulus to the volume of the tubing above the chamber must be determined.
3. The maximum static fluid gradient at depletion should be used.
4. The maximum working fluid level between gas injections must be known.
5. The location of the packer in relation to the top of an insert chamber is important if a small dip tube is employed.
6. The volume of the dip tube must be considered if the dip tube is larger than the tubing.

Design considerations. Additional chamber design considerations which affect the overall operational efficiency are as follows:

1. The unloading valve immediately above the operating valve must be properly located.
2. The bleed port should be correctly sized to pass the formation gas.
3. A partially balanced flow valve is necessary for most chamber installations to reduce the spread of the operating valve.
4. The packer combination for a two-packer installation will depend on the individual well conditions and desired expenditure.
5. Retrievable equipment will provide maximum efficiency and eliminate pulling tubing for valve replacement. ★ ★ ★



An entire lease is controlled accurately and precisely in minutes through this battery of Willis Rotary Adjustable Chokes.

6 ways better

flow control

PROVIDES 6 different sized choke inserts which are individually positioned in the line of flow by a fractional turn of the orifice-carrying disc . . . under constant flow and high pressure.

The 6 graduated orifices are changed to a new range in minutes...without shutting-in the well.

A positive shut-in is made by inserting a blank orifice.

WILLIS OIL TOOL COMPANY

3440 Pine Ave., Long Beach 7, California

Houston: 2012 Taft Street **Odessa: 100 N. Texas Street**

B-103

Part 2

Electrical Resistivities of Oil Field Brines

In South Arkansas and North Louisiana

Murphy E. Hawkins[1] and J. L. Moore[2]

Data and maps on 21 North Louisiana parishes. Information to aid log interpretation, location of casing leaks and formation identification.

TABLE 5. Resistivities of water samples, Caddo and Bossier Parishes, Louisiana.

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Caddo Parish, Louisiana		
1	Rodessa	Rodessa	5760-5830	0.044
2	Caddo-Pine Island	Nacatoch	1000-1100	.218
2	Caddo-Pine Island	Annona	1500-1700	.225
2	Caddo-Pine Island	Paluxy	2200-2250	.148
2	Caddo-Mooringsport	Sligo (Pettet)	5525-5550	.052
2	Caddo-Vivian	Paluxy	2500	.136
2	Caddo-Hosston	Nacatoch	1100	.224
3	Rockpoint	Rodessa (Kilpatrick)	3750	.049
4	Dixie	Paluxy	2440	.152
5	Longwood	Undifferentiated (Georgetown)	2350	.153
5	Longwood	Sligo (Pettet)	5600	.049
5	Longwood	Hosston	6010-6030	.050
6	East Greenwood	Mooringsport	3750-3800	.144
6	East Greenwood	Rodessa (Hill)	4900	.056
7	Waskom	Mooringsport	3750	.142
7	Waskom	Sligo (Pettet)	5600	.055
7	Waskom	Hosston	5970	.056
8	Shreveport	Sligo (Pettet)	5550	.056
		Bossier Parish, Louisiana		
1	North Carterville	Sligo (Pettet)	6100	.050
2	Arkana	Smackover	10,730-10,760	.046
3	Plain Dealing	Tokio	3230-3260	.123
4	Redland	Ozan (Buckrange)	2900	.113
4	Redland	Sligo (Pettet)	6300	.052
4	Redland	Hosston	7380	.048
5	Carterville	Tokio	3118-3164	.112
6	Miller's Bluff	Paluxy	2880	.150
7	Cottage Grove	Ozan (Buckrange)	1930	.207
8	Ivan	Smackover	9670-9740	.045
9	Benton	Cotton Valley (Schuler)	8100-8400	.042
10	Bellevue	Nacatoch	420	.246
10	Bellevue	Brownstown (Blossom)	1440	.150
11	Bossier City	Sligo (Pettet)	5550	.056
12	Sligo	Paluxy	3000-3025	.108
12	Sligo	Mooringsport (Schuler Lime)	3150	.097
13	Elm Grove	Ozan	1500	.210
14	Loggy Bayou	Paluxy	2730	.127

FIG. 9. **Source of water samples collected in Caddo and Bossier Parishes, Louisiana.**

1. Petroleum engineer, U. S. Bureau of Mines, Dallas, Texas.
2. Petroleum engineer, formerly with the U. S. Bureau of Mines, Dallas.

Editor's Note: Part I, published last month, contained background information of this Bureau of Mines project. Electrical resistivities of oil field brines in 7 counties of southern Arkansas were given in tabular form accompanied by county maps showing where water samples were taken.

Part 2 is a continuation of this report, and includes electrical resistivity data of oil field brines from 21 parishes in Northern Louisiana. Before these resistivities can be used in electric log interpretations, they must be adjusted to the appropriate formation temperature by referring to the curves shown in Fig. 2 of Part 1. These resistivity data permit quantitive analysis of electric logs to determine porosity and connate water saturation. Examples of their use were given in the preceding part.

AXELSON PICTORIAL

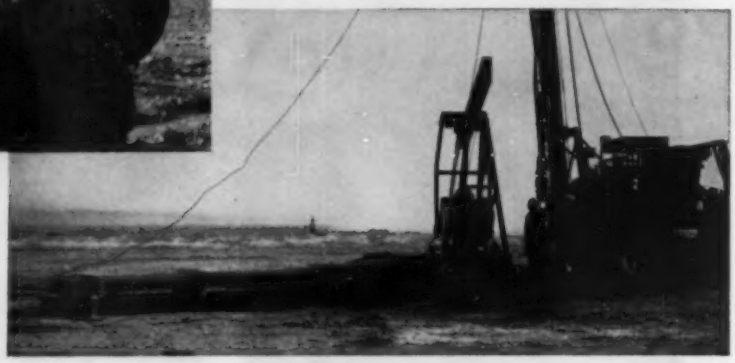
PALOMA. This well (Chanslor-Western Oil Development #34-55) is 100% Axelson equipped with rod-type pump (2 x 1¼ x 36 x 40), a 4-step Axelson sucker rod string (#59 rods), and an Axelson 25 ft. Hydraulic Pumping Unit. Pump shoe will be set at 11,532 ft. Checking equipment is Don Donley, Axelson District Manager, Bruno Clouse, Production Foreman for CWOD, and Leonard Morgan, Toolpusher, CWOD.

2 MILLION BARRELS. George Ledbetter (left), Production Foreman, Bakersfield Division, General Petroleum Corporation; and Earl Colvin, Axelson Representative, at the Glide 21 No. 10 in the Mount Poso Field, Kern County, California. A 4" x 3¾" x 11' Axelson Tubing Pump equipped with Duax Liners and a 48" minus 3 heavy chrome-plated grooved plunger is in service. As of March 9, 1956, the pump has produced over two million barrels of gross fluid averaging 2,250 BPD over a 2½ year span without having been pulled.

ODESSA WAREHOUSE. The Axelson sales office and warehouse, located at 2512 West 2nd Street, Odessa, is the center for hydraulic pumping units in West Texas and Southwest New Mexico. Immediate delivery, installation and service originate from this point. Call Federal 7-8391 for prompt attention to your pumping requirements in the Permian Basin.

PROTECTION PAYS OFF. Wendall Weaver, Roustabout for Forest Oil Corporation, removes the protective caps from the ends of ¾" Axelson Sucker Rods. Both box and pin ends of Axelson rods are protected to keep dirt out of threads during shipment and storage. S. J. "Sid" Ingram, Field Superintendent looks on.

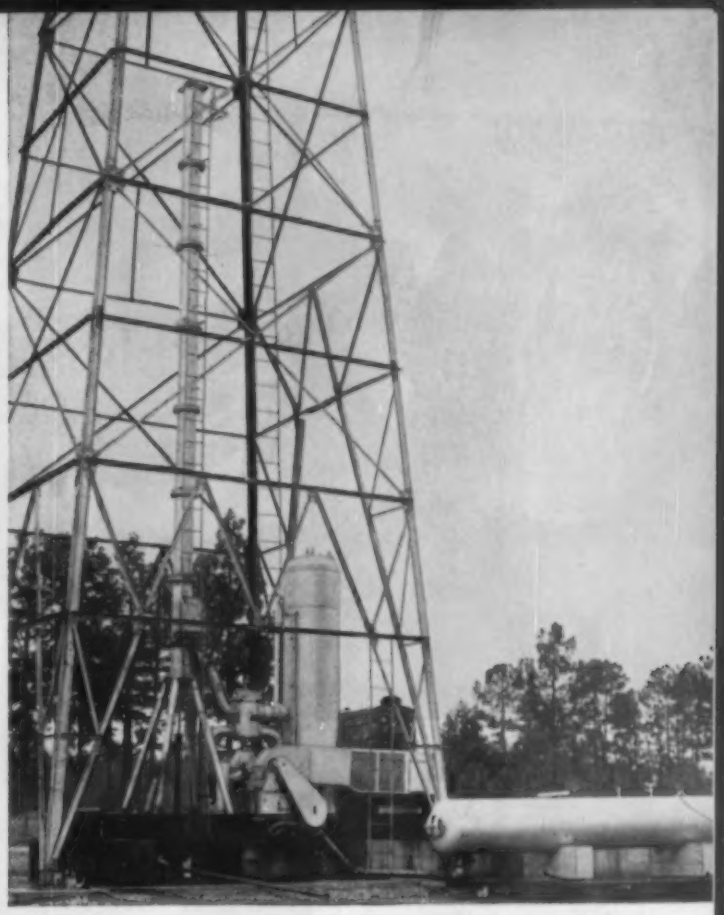
ON THE PUMP. Forest Oil Corporation's Blakeney "M" 2-H at East Goldsmith, Texas, is going on the pump. Alexson ¾" #59 sucker rods have just been delivered. These rods are made from a nickel-modybdenum alloy steel fully normalized and tempered from end to end. They are recommended for wells in which heavy loads and corrosion are a problem.



W. O. C. Pumpers J. F. Ham (left) and E. J. Little, Magnolia Petroleum, wait on cement during a squeeze job in progress in the Geo. Hearder #1, Brownfield District, Andrews County, Texas. Too much water in production called for remedial work. The Axelson Hydraulic Long Stroke pumping unit will be reset at a different level to get maximum production at reduced pumping rates.

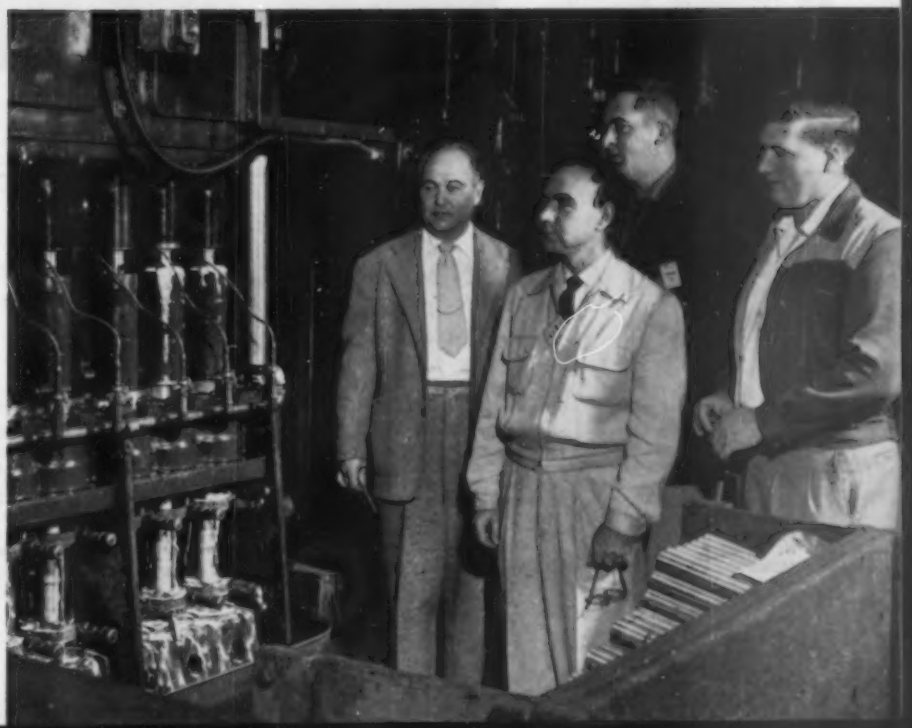
GOVERNOR. Visiting the Axelson booth at a recent industrial exposition in Los Angeles, was Goodwin J. Knight, Governor of California, with the Governor are Mrs. Doug Lance (center), wife of Axelson's Sales Promotion Manager and Mrs. Knight.

AXELSON PICTORIAL



SLOW MOTION. In the beautiful pine-tree country around the Lake Charles District, Louisiana, this Axelson Hydraulic Long Stroke Unit pumps 156 BPD from a depth of 8,600 ft. @ 3½ strokes a minute with a 26½ ft. stroke. The slow, smooth, steady loading of these powerful pumping units reduces stresses on sucker rods and on the moving parts of subsurface pumps, thereby increasing their life manyfold. This well is Magnolia Petroleum's Lutcher Moore #C-2.

IN FOCUS. This is Drilling & Exploration Company's able well service crew on the job in the Wasson Field, Texas. These fellows have installed many an Axelson pump and sucker rod string which are sold and serviced through the local Jones & Laughlin Supply Stores. (From left to right) Garnice Land, Clint Westbrook (Gang Pusher), Stanley Smith.



FOURSOME. Viewing the liner-boring machine at Axelson's Los Angeles plant: (left to right) Phil Humphreys, Axelson Petroleum Sales, Los Angeles; Jay Gordon and Andy Throop, Union Oil Company Production Foremen, Dominguez District; Al Thompson, Axelson Factory Representative, Long Beach. Petroleum personnel frequently make a tour of Axelson's vast manufacturing facilities and are always welcome.

AXELSON PICTORIAL

PRETTY MODEL. Watching the Axelson pump model are members of a petroleum production class at the University of California at Los Angeles. This plug-in working model has a plastic jacket permitting all parts to be seen in operation. A motor operates the rod and plunger and oil is lifted to the top where it flows back into the reservoir at the bottom. The model is available to schools and colleges for demonstrations. Instructor is Max Taves (third from left) Reservoir Engineer, Richfield Oil Corporation.

NORTH BELRIDGE. Axelson red working barrels are used exclusively by Ferguson & Bosworth Oil Company in the North Belridge Field, Kern County. This well (Layman #25) was completed at 3,100 ft. An Axelson Duax Tubing Pump, 2 x 1¾ x 7, will pump about 50 B/D of 26 gravity oil. The well filled with 300 ft. of sand on completion and is being bailed out by a well crew from Jack Lunn Production Service, Taft. Left to right: Jim Ferguson, Jim Gingrich (Production Superintendent for Ferguson & Bosworth), Leroy Cook (Gang Pusher), Don Bridgewater, Chuck Cook.

No. 5

Specify **AXELSON** *for*
Subsurface Pumps
Sucker Rods
Hydraulic Pumping Units
Stuffing Boxes & Packing
for better production

AXELSON

AXELSON MANUFACTURING COMPANY

Division of U. S. Industries, Inc.

6160 South Boyle Avenue, Los Angeles 58, California

Where to buy Axelson Production Equipment:

CALIFORNIA: *Axelson stores at Bakersfield, Coalinga, Huntington Beach, Long Beach, Orcutt, Santa Fe Springs, Taft, Ventura; Hickey Pipe & Supply Co. (Sucker Rods)* • **MID-CONTINENT:** *Jones & Laughlin Steel Corporation, Supply Division (Headquarters, Tulsa)* • **PERMIAN BASIN:** *Axelson Warehouse, Odessa (Hydraulic Pumping Units only).* • **ROCKY MOUNTAINS:** *Jones & Laughlin Steel Corporation, Supply Division; Great Northern Tool & Supply Co., Billings, Montana* • **CANADA:** *Jones & Laughlin Steel Sales Co. Ltd., Calgary; Dominion Oilfield Supply Co. Ltd., Calgary* • **MEXICO, D. F.:** *Wells Fargo & Co. Express, S. A.* • **RIO DE JANEIRO, BRAZIL:** *MAQUIP (Commercial de Maquinas e Equipamentos) S. A.* • **LIMA, PERU:** *Gross Equipment, S. A.* • **LA PAZ, BOLIVIA:** *Del Prado & Compania. Ltd.* • **BUENOS AIRES, ARGENTINA:** *Adrian Bolland & Cia., S. R. L.* • **BARCELONA, VENEZUELA:** *Servicios Industriales, C. A.* • **MARACAIBO, VENEZUELA:** *Servicios Industriales, C. A.* • **COLOMBIA:** *Servicios Industriales, C. A.* **TRINIDAD, B. W. I.:** *Industrial Agencies, Ltd.*

TABLE 6. Resistivities of water samples, DeSoto, Red River, Sabine, and Natchitoches Parishes, Louisiana.

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Desoto Parish, Louisiana		
1	Holly	Eagleford	2800-2830	0.159
2	Red River-Bull Bayou	Paluxy	2600-2700	.163
2	Red River-Bull Bayou	Rodessa	5016-5039	.044
3	Logansport	Rodessa	4981-5024	.047
4	Grogan	Nacatoch	1200	.208
4	Grogan	Paluxy	2840	.095
		Red River Parish, Louisiana		
1	Red River-Bull Bayou	Paluxy	2600-2700	.163
2	Lake End	Nacatoch	1236	.185
		Sabine Parish, Louisiana		
1	Pleasant Hill	Paluxy	3240	.126
2	Converse	Annona	1820	.176
3	Blue Lake	Annona	2100-2125	.177
4	Zwolle	Annona	2600	.149
4	Zwolle	Rodessa	5266-5277	.045
4	Zwolle	Rodessa	5730-6000	.044
		Natchitoches Parish, Louisiana		
1	Ashland	Tuscaloosa (Detro sand)	3275-3300	.087

FIG. 10. **Source of water samples collected in DeSoto, Red River, Sabine and Natchitoches Parishes, La.**

TABLE 7. Resistivities of water samples, Webster and Claiborne Parishes, Louisiana.

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Webster Parish, Louisiana		
1	North Shongaloo	Sligo (Pettet)	5750-5800	0 051
2	Springhill	Tokio	3100	.099
3	Sarepta	Brownstown (Blossom)	2700	.109
4	Cotton Valley	Tokio (Blossom)	2520-2560	.103
4	Cotton Valley	Rodessa (Davis)	4683	.052
4	Cotton Valley	Rodessa	4851	.054
4	Cotton Valley	Sligo (Pettet)	5525	.061
4	Cotton Valley	Cotton Valley	8530-8640	.044
5	Ada	Mooringsport	4400	.073
6	Sibley	Rodessa (Jones)	5700-5720	.055
		Claiborne Parish, Louisiana		
1	Haynesville	Ozan (Blossom)	2680-2700	.121
1	Haynesville	Tokio (Buckrange)	2850	.110
1	Haynesville	Sligo (Pettet)	5200-5400	.048
1	Haynesville	Cotton Valley (Taylor)	8920-9063	.043
2	East Haynesville	Rodessa (Gloyd)	4420	.053
2	East Haynesville	Sligo (Birdsong-Owens)	5175-5200	.055
3	Homer	Nacatoch	1100	.144
4	Bayou Middle Fork	Cotton Valley(Bodcaw)	7760	.053
5	Summerfield	Smackover	10,300-10,400	.045
6	Lisbon	Sligo (Pettet)	5100-5300	.051
7	Athens	Sligo (Pettet)	6300	.051
7	Athens	Hosston	7400	.049
8	Sugar Creek	Hosston	5710-5730	.051
8	Sugar Creek	Cotton Valley	9200	.044

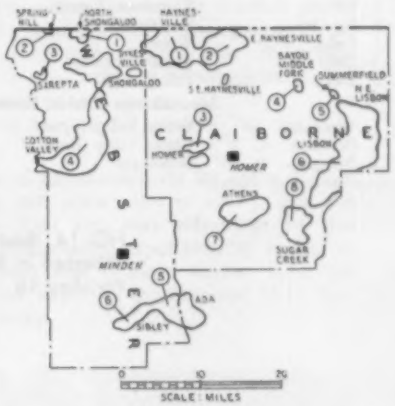


FIG. 11. **Source of water samples collected in Webster and Claiborne Parishes, La.**

TABLE 8. Resistivities of water samples, Bienville and Lincoln Parish

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Bienville Parish, Louisiana		
1	Ada	Mooringsport	4400	0.073
2	Lake Bistineau	Sligo (Pettet)	5100-5300	.054
3	Sailes	Sligo (Pettet)	6800-6860	.057
4	Alabama Bend	Paluxy	2780-2800	.112
5	Saline	Hosston	9750-9825	.044
		Lincoln Parish, Louisiana		
1	Hico-Knowles-Dubach	Pine Island (Woodruff)	5040	.053

FIG. 12. **Source of water samples collected in Bienville and Lincoln Parishes, La.**

TABLE 9. Resistivities of water samples, Union Parish, Louisiana.

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
1	Oakland	Nacatoch	2240	0.106
2	Truxno	Nacatoch	2210-2250	.108
3	Ora	Nacatoch	2100	.121
3	Ora	Ozan (Meakin)	2425	.102
4	Cecil Area	Cotton Valley	5525	.052
4	Cecil Area	Smackover	7980-8050	.043
5	Downsville	Hosston	7380	.051

FIG. 13. **Source of water samples** collected in Union Parish, La.

TABLE 10. Resistivities of water samples, Richland and Morehouse Parishes, Louisiana.

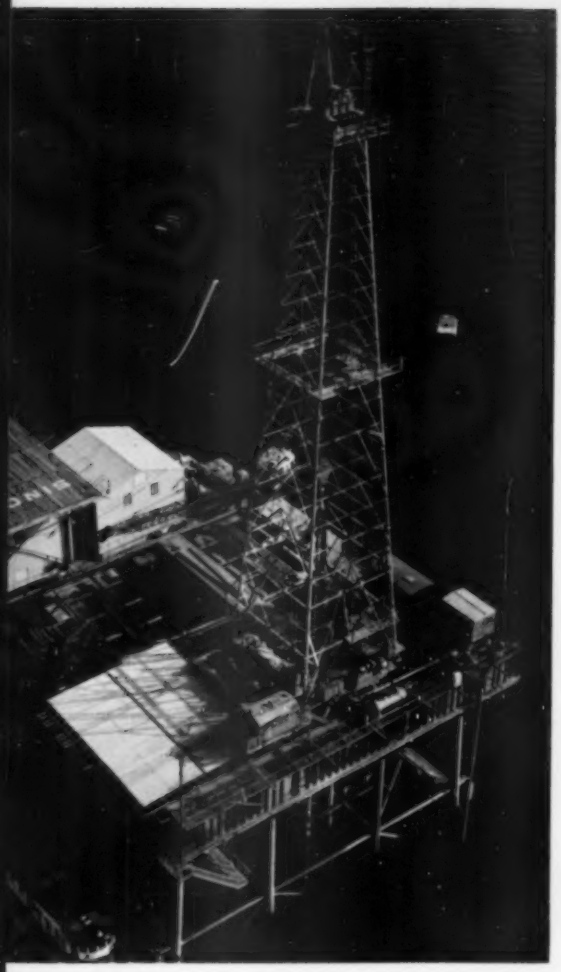
Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Richland Parish, Louisiana		
1	Dehleo	Tuscaloosa (Upper)	2600-2625	0.089
2	Big Creek	Tuscaloosa	2810-2930	.097
3	Delhi	Wilcox	2125	.170
3	Delhi	Tuscaloosa (May)	3250-3350	.083
3	Delhi	Paluxy (Holt)	3300-3400	.082
		Moorehouse Parish, Louisiana		
1	Beekman	Cotton Valley (Upper)	3660	.069
1	Beekman	Cotton Valley (Basal)	6000	.053
1	Beekman	Smackover	6180	.042

FIG. 14. **Source of water samples** collected in Richland and Morehouse Parishes, La.

TABLE 11. Resistivities of water samples, Franklin, Madison, and Tensas Parishes, Louisiana.

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Franklin Parish, Louisiana		
1	South Big Creek	Tuscaloosa	3400	0.077
2	Delhi	Wilcox	2125	.170
2	Delhi	Tuscaloosa (May)	3250-3300	.083
2	Delhi	Paluxy (Holt)	3300-3400	.082
3	Southwest Delhi	Tuscaloosa (Marine)	3620-3660	.078
		Madison Parish, Louisiana		
1	Delhi	Wilcox	2125	.170
1	Delhi	Tuscaloosa (May)	3250-3350	.083
1	Delhi	Paluxy (Holt)	3300-3400	.082
2	Indian Lake	Tuscaloosa	5630	.066
		Tensas Parish, Louisiana		
1	Holly Ridge	Wilcox	3000-3030	.068
1	Holly Ridge	Tuscaloosa (Lower)	8400	.067
2	Helena	Tuscaloosa (Lower)	8900	.072
3	Lake St. John	Wilcox ("A" sand)	3400-3500	.084
3	Lake St. John	Wilcox ("B" sand)	3400-3500	.085
3	Lake St. John	Wilcox ("C" sand)	3400-3500	.081
3	Lake St. John	Wilcox	3925-4000	.075
3	Lake St. John	Wilcox	4500-4550	.067
3	Lake St. John	Tuscaloosa (Lower)	9080-9160	.061

FIG. 15. **Source of water samples** collected in Franklin, Madison, and Tensas Parishes, La.



DESIGNED FOR THE JOB . . .

Offshore

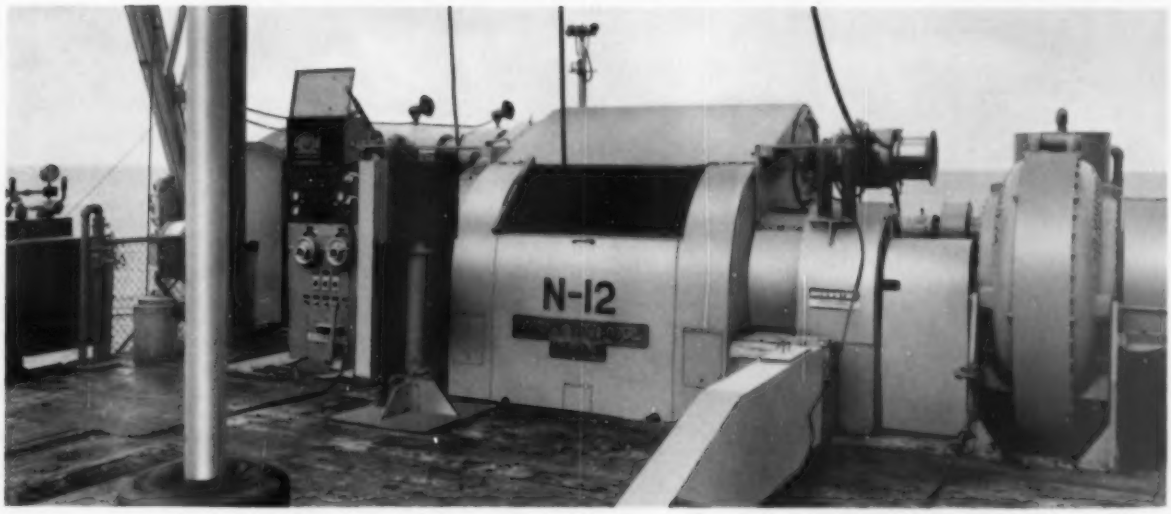
Brewster N-12 with Rigelectric

Here is a team that is winning the race for more speed and power on deep offshore wells . . . Brewster N-12 with Rigelectric Power.

Now at work in LaFourche Field, this Brewster built Rimrock Tidelands Rig 3 has the power and stamina to drill the worlds deepest well.

Working with Rigelectric equipment men, Brewster engineered the N-12 drawworks to obtain maximum advantage of diesel-electric power. At a touch of the controls the driller can put 1,250 horsepower at the drum to speed a long string of drill pipe off bottom. With equal ease he can direct 1,875 horsepower to the mud pumps . . . start or stop any auxiliary . . . all without effort, or leaving his position at the control panel.

The smooth flow of full horsepower for every drilling task is bringing new speed and economy into the offshore picture. You can take advantage of this diesel-electric manufacturing experience by calling in Brewster when your new offshore venture is in the planning stage. Ask today for the Brewster N-12 Rigelectric offshore story . . .



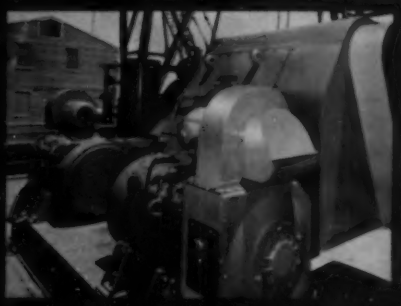
BREWSTER N-12 DRAWWORKS

2000 HORSEPOWER AT THE DRILLER'S COMMAND

Amazingly simple the control panel for the N-12 electric rig gives the driller effortless command of every operation. His full attention can be concentrated on the job, which promotes greater crew safety and faster drilling.
Mounted as an integral part of the drawworks, the control panel need not be disconnected when moving the rig.

1250 HORSEPOWER AT THE DRAWWORKS

Designed for the job . . . the N-12 drawworks transmission is equipped with dual input drives each connected to a 625-hp. electric motor. The two-speed transmission, coupled with high and low drives at the drum, gives four hoisting ratios to supplement the infinite speed range possible with the electric motors. Short in length the drawworks package requires a minimum of deck room . . . can be skidded around to permit six or 12 well drilling.



1875 HORSEPOWER AT THE MUD PUMPS

Flexibility of equipment placement is of major importance on space-limited offshore platforms. One 16-inch pump has been unitized completely with 625-hp. electric motor. One 18-inch pump has been unitized with 2 – 625-hp. electric motors. They can be skidded into the most favorable position for manifolding to the mud lines. Only an electric cable need be laid to obtain full driving power.

2000 HORSEPOWER AT THE GENERATORS

Completely packaged the Rigelectric generating units occupy a minimum of space . . . can be placed anywhere on the platform without regard to drawworks or pump location. Individually skidded as single units, the generator sets require only connection to fuel lines to go to work.

THE BREWSTER COMPANY, INC.
Shreveport, Louisiana

SUPPLY HOUSES

Howard Supply Company

Apex Equipment Company

Bovaird Supply Company

Industrial Supply Company

Murray Brooks, Inc.

United Supply and Manufacturing Company

For Canada, Mexico and Export Sales:
The Brewster Company

FIG. 16. **Source of water samples collected in Catahoula and Concordia Parishes, La.**

TABLE 12. Resistivities of water samples, Catahoula and Concordia Parishes, Louisiana.

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Catahoula Parish, Louisiana		
1	Manifest	Sparta	1800	0.125
2	Pool Lake	Wilcox	4590-4600	.069
3	Big Bayou	Wilcox	5160	.065
4	North Saline Lake	Wilcox	5500	.064
5	Saline Lake	Wilcox	5950	.060
		Concordia Parish, Louisiana		
1	Lake St. John	Wilcox ("A" sand)	3400-3500	.084
1	Lake St. John	Wilcox ("B" sand)	3400-3500	.085
1	Lake St. John	Wilcox ("C" sand)	3400-3500	.081
1	Lake St. John	Wilcox	3925-3950	.075
1	Lake St. John	Wilcox	4500-4550	.067
1	Lake St. John	Tuscaloosa	9080-9160	.061
2	Wildville	Wilcox	5130	.064
3	Ross Bayou	Wilcox (E-2 sand)	5100	.068
3	Ross Bayou	Wilcox (E-5 sand)	5625	.060
4	Vidalia	Wilcox	5650	.060
5	Lismore Landing	Wilcox (E-2 sand)	5320	.067
5	Lismore Landing	Wilcox (E-5 sand)	5825	.060
6	Esperance Point	Wilcox	6260-6270	.066
7	Deer Park	Wilcox	5980-5990	.068

FIG. 17. **Source of water samples collected in Winn, LaSalle and Rapides Parishes, La.**

TABLE 13. Resistivities of water samples, Winn, LaSalle, and Rapides Parishes, Louisiana.

Map index	Field	Formation	Average or range in depth, feet	Average resistivity, Rw at 75 F, ohm-meter
		Winn Parish, Louisiana		
1	Joyce	Wilcox	1150	0.200
		LaSalle Parish, Louisiana		
1	Tullos-Urania	Wilcox	1515	.126
2	Olla	Wilcox	2225-2250	.102
3	Summerville	Wilcox	2500-2650	.092
4	Zenoria-Little Creek	Wilcox	2430-2475	.096
5	Trout Creek	Sparta	1500	.144
5	Trout Creek	Wilcox	3400	.090
5	Trout Creek	Wilcox	3600	.085
6	East Nebo	Wilcox	3900	.081
7	Nebo-Hemphill	Wilcox	4025	.077
8	Catahoula Lake	Wilcox	4090-4100	.076
9	West Catahoula Lake	Wilcox	4140	.075
10	North Saline Lake	Wilcox	5500	.064
11	Saline Lake	Wilcox	5950	.060
		Rapides Parish, Louisiana		
1	Big Island	Wilcox	5400	.067
1	Big Island	Tuscaloosa	9680-9700	.064

Acknowledgments

This report was prepared by engineers of the Bureau of Mines under cooperative agreements with the Arkansas Oil and Gas Commission and the Louisiana Department of Conservation. The writers gratefully acknowledge the cooperation and assistance of O. C. Bailey, chairman; P. M. McLaughlin, former director; George B. Holden, director; Walter L. Dobie, chief geologist; and other members of the Arkansas Oil and Gas Commission. They also acknowledge the assistance of John B. Hussey, commissioner; Thomas M. Winfiele, chief engineer; and other members of the Louisiana Department of Conservation.

Special acknowledgments are due the officials and employees of the 96 oil companies who made this report possible by supplying water samples and water-analysis data. ★ ★ ★

1,000,000 Wells Logged

Schlumberger Passes Milestone

Schlumberger Well Surveying Corporation has passed a new milestone — the millionth operation of Schlumberger was recorded recently when an electrical log was run on an Humble Oil & Refining Company well at the Danbury field in Brazoria County, Texas.

W. J. Gillingham, executive vice president of Schlumberger, personally handed the electrical log to J. A. Neath, chairman of the board of Humble, and to Ed Hamner, director of exploration.

The well, Humble's Danbury Gas Unit Number 6, Well No. 1, was logged to 7812 ft.

Witnessing the operation were about 40 Schlumberger and Humble officials and members of the press, radio and television. Also present were the owners of the land on which Humble is drilling — Mrs. H. G. Crotty of Galveston, Texas, and Mrs. C. J. Garbs of Crosby, Texas.

In addition to the log, Neath was given a bronze plaque commemorating the event.

At a luncheon preceding the millionth operation, Gillingham traced the rapid growth of Schlumberger since its founding in 1934 and stressed the attention given by Schlumberger to research which is necessary to keep abreast of the

Otis...
"First in Pressure Control"

Participants in Millionth Operation—Top officials of the Schlumberger Well Surveying Corporation and Humble Oil and Refining Company were on hand Tuesday when Schlumberger ran its millionth operation. It was in the form of an electrical log on an Humble Oil and Refining Company well in the Danbury field, Brazoria County, Texas. Left to right are W. J. Gillingham, Schlumberger executive vice president; Ed Hamner, director of exploration for Humble, and J. A. Neath, Humble's chairman of the board.

changing needs of the oil industry.

He noted that when the company opened its new headquarters plant in Houston in 1953 there were 186 engineering and research employees. Today, there are 335.

Schlumberger in 1953 produced 85 service units. This year, Gillingham said, 160 units will be turned out.

Gillingham cited four basic reasons for the rapid expansion of Schlumberger and the design of new tools.

One is the great increase in number of wells drilled in recent years. Another is the upsurge in offshore activity. A third is the trend to smaller diameter holes and a fourth is the deep drilling and resulting high pressures and temperatures.

Of the 160 units to be constructed this year, 70 are headed for offshore assignments.

Since 1953 at its Houston headquarters, Schlumberger has added an instrument shop, doubled warehouse space, added a cable shop and increased space in its truck shop by 20 per cent.

The company now is planning construction of a new engineering building to contain 54,000 sq ft of floor space.

Gillingham emphasized one of the problems facing his company is the acquiring of graduate engineers. The corporation must hire 120 engineers a year to keep pace with its expanding business.

Total employment has increased from 2600 in 1953 to 3800 today.

Other Schlumberger officials attending the millionth operation included J. C. Legrand of Ridgefield, Connecticut, vice president in charge of patents; D. C. McCann, vice president of field operations; A. Blanchard, vice president of engineering; M. P. Tixier, head of field development, and R. R. Rieke, sales manager. All are from Houston excepting Legrand.

Other Humble officials present were Douglas Bell, head of production geology; R. K. Tracy, division production superintendent, Gulf Coast Division, and R. L. Denham, division geologist, Gulf Coast Division. ★ ★ ★

OTIS BOTTOM-HOLE REGULATORS

Prevent Flow Line Freeze-Ups, Eliminate Surface Heaters, Reduce Surface Pressure — By moving the point of pressure reduction from the surface to the bottom of the hole, Otis Removable Bottom Hole Regulators choke back well pressures at a point deep in the tubing string, where the sub-surface temperature is high. Thus the tubing can be used as a "sub-surface heater" to reheat the gas after expansion — before it reaches the surface. Costly installation and maintenance of heaters for surface connections can be dispensed with entirely. Otis Regulators afford all of the advantages of bottom hole choking and automatically reduce the flowing pressure to safe, workable limits at the surface, regardless of the rate of withdrawal. Contact your nearest Otis office for complete details on the many advantages of this versatile tool. There is no obligation, and afterward you will be better informed on better production practices for your flowing wells.

OTIS PRESSURE CONTROL, INC.

Branches Throughout the Oil Country

1,000,000 Wells Logged

Schlumberger Passes Milestone

Schlumberger Well Surveying Corporation has passed a new milestone — the millionth operation of Schlumberger was recorded recently when an electrical log was run on an Humble Oil & Refining Company well at the Danbury field in Brazoria County, Texas.

W. J. Gillingham, executive vice president of Schlumberger, personally handed the electrical log to J. A. Neath, chairman of the board of Humble, and to Ed Hamner, director of exploration.

The well, Humble's Danbury Gas Unit Number 6, Well No. 1, was logged to 7812 ft.

Witnessing the operation were about 40 Schlumberger and Humble officials and members of the press, radio and television. Also present were the owners of the land on which Humble is drilling — Mrs. H. G. Crotty of Galveston, Texas, and Mrs. C. J. Garbs of Crosby, Texas.

In addition to the log, Neath was given a bronze plaque commemorating the event.

At a luncheon preceding the millionth operation, Gillingham traced the rapid growth of Schlumberger since its founding in 1934 and stressed the attention given by Schlumberger to research which is necessary to keep abreast of the

Otis...
"First in Pressure Control"

Participants in Millionth Operation—Top officials of the Schlumberger Well Surveying Corporation and Humble Oil and Refining Company were on hand Tuesday when Schlumberger ran its millionth operation. It was in the form of an electrical log on an Humble Oil and Refining Company well in the Danbury field, Brazoria County, Texas. Left to right are W. J. Gillingham, Schlumberger executive vice president; Ed Hamner, director of exploration for Humble, and J. A. Neath, Humble's chairman of the board.

changing needs of the oil industry.

He noted that when the company opened its new headquarters plant in Houston in 1953 there were 186 engineering and research employees. Today, there are 335.

Schlumberger in 1953 produced 85 service units. This year, Gillingham said, 160 units will be turned out.

Gillingham cited four basic reasons for the rapid expansion of Schlumberger and the design of new tools.

One is the great increase in number of wells drilled in recent years. Another is the upsurge in offshore activity. A third is the trend to smaller diameter holes and a fourth is the deep drilling and resulting high pressures and temperatures.

Of the 160 units to be constructed this year, 70 are headed for offshore assignments.

Since 1953 at its Houston headquarters, Schlumberger has added an instrument shop, doubled warehouse space, added a cable shop and increased space in its truck shop by 20 per cent.

The company now is planning construction of a new engineering building to contain 54,000 sq ft of floor space.

Gillingham emphasized one of the problems facing his company is the acquiring of graduate engineers. The corporation must hire 120 engineers a year to keep pace with its expanding business.

Total employment has increased from 2600 in 1953 to 3800 today.

Other Schlumberger officials attending the millionth operation included J. C. Legrand of Ridgefield, Connecticut, vice president in charge of patents; D. C. McCann, vice president of field operations; A. Blanchard, vice president of engineering; M. P. Tixier, head of field development, and R. R. Rieke, sales manager. All are from Houston excepting Legrand.

Other Humble officials present were Douglas Bell, head of production geology; R. K. Tracy, division production superintendent, Gulf Coast Division, and R. L. Denham, division geologist, Gulf Coast Division. ★ ★ ★

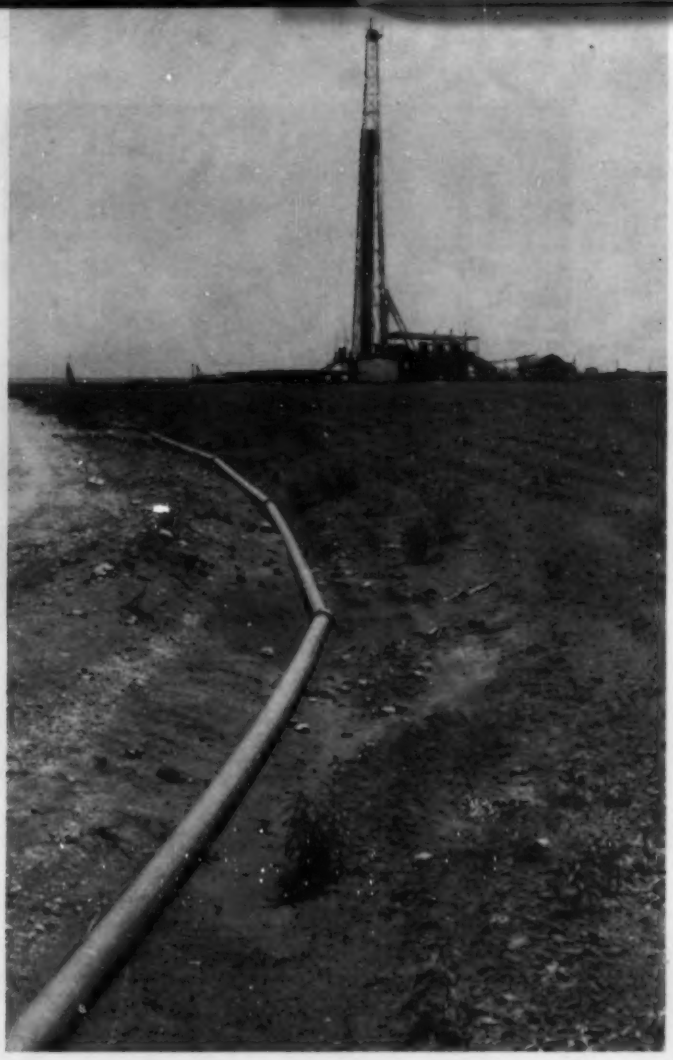
OTIS BOTTOM-HOLE REGULATORS

Prevent Flow Line Freeze-Ups, Eliminate Surface Heaters, Reduce Surface Pressure — By moving the point of pressure reduction from the surface to the bottom of the hole, Otis Removable Bottom Hole Regulators choke back well pressures at a point deep in the tubing string, where the sub-surface temperature is high. Thus the tubing can be used as a "sub-surface heater" to reheat the gas after expansion — before it reaches the surface. Costly installation and maintenance of heaters for surface connections can be dispensed with entirely. Otis Regulators afford all of the advantages of bottom hole choking and automatically reduce the flowing pressure to safe, workable limits at the surface, regardless of the rate of withdrawal. Contact your nearest Otis office for complete details on the many advantages of this versatile tool. There is no obligation, and afterward you will be better informed on better production practices for your flowing wells.

OTIS PRESSURE CONTROL, INC.

Branches Throughout the Oil Country

Temporary water lines to drilling rigs is one popular application found by aluminum pipe. It can be rented or purchased. Light weight and detachable couplings permit speed of installation.



Lightweight 30-ft sections of 4-in. aluminum pipe can be carried easily by one man. This truck can handle over 20 such joints.

Many Advantages for . . .

ALUMINUM PIPE In Oil Field Operations

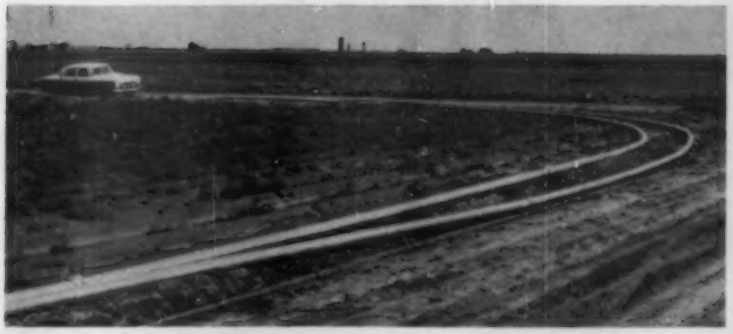
P 615.23

Lightweight sections with fast-make couplings find new uses from temporary fuel and water lines to handling corrosive fluids

WELDED aluminum pipe, tested in the mill to withstand 1000 psi, is now in service in oil fields throughout Texas, Colorado, Louisiana, Kansas, and Oklahoma. Operating installations of aluminum petroleum pipe have been made for fuel gas and water supply lines on a number of drilling rigs and the pipe is now beginning to find extensive application for secondary recovery by salt water injection, salt water disposal, low-pressure flow lines, and gathering systems.

Aluminum pipe offers exceptional corrosion resistance, resistance to paraffin deposition and remarkable durability. No corrosion has been observed from service in gas supply lines, and in service lines to drilling rigs, after six to nine month's experience, corrosion was limited to a superficial white film of oxide. Where pipe has been buried for road crossings, at a depth as shallow as the diameter of the pipe, no damage from crossing vehicles or soil corrosion has been observed. Where pipe has been laid above ground and driven over by vehicles, it has been bent but not broken, and has remained serviceable.

A distinct advantage of aluminum pipe, of course, is its extreme portability. Weighing approximately one-tenth as much as welded steel pipe of equal diameter, it is possible to carry aluminum pipe into otherwise inaccessable places. Considerable economics in transportation are also effected by its use. For example, 224 thirty-foot lengths have been carried by a truck that could have carried only 75 lengths of 25-ft 4-in. I.P.S. steel pipe.



90-degree bend of 4-in. pipe can be made in just four joints without the aid of special fittings.

Leakproof connection is made by hand pressure only with this special coupling, one of several types in use. Couplings are flexible and seal at pressures up to 1000 psi in both gas and liquid service.

Several different types of couplers, as well as elbows, tees and other standard fittings are available. Couplers are made of cast aluminum and share the basic design principle of engaging the flared, or flanged ends of the pipe sections with "O" rings or molded-type neoprene gaskets seated in the coupler bodies by means of threaded locking nuts. The locking nuts require only hand pressure with a 6-in. spanner wrench to assure leak-proof connections at pressures from 0 to 1000 psi in both liquid and gas service.

Welded aluminum pipe can be flanged by hand tools in the field, or by power machinery. Special lengths can be made in the field by cutting the pipe to the desired length, slipping a coupler over the tube and then flanging and connecting. No welding is required.

Design of the couplers also provides considerable flexibility. This flexibility permits aluminum pipe to curve around obstacles and to follow rises and dips along the surface of the ground. It is possible to make a 90-deg turn in 4 thirty-foot lengths of pipe without the use of elbows or other special connections.

Aluminum pipe is roll-formed and welded from high-strength aluminum sheet. Both inside and outside surfaces are clad with a special aluminum alloy to provide increased resistance against corrosion. The pipe has a design pressure of above 1500 psi, with a guarantee test pressure of 1000 psi and a recommended operating pressure of 500 psi, providing a nominal safety factor of 3 to 1.

Experience now indicates that aluminum pipe systems can be provided and installed at no additional cost. It is currently available in 2, 3 and 4-in. diameters.

Acknowledgment

Photographs used as illustrations were supplied through the courtesy of Kaiser Aluminum & Chemical Corporation.

* * *

What the WELL-DRESSED, MEDIUM-PRESSURE Wells are wearing

This well is equipped with the compact "Tee Base Type" HERCULES Duplex Stuffing Box and HERCULES "Type SO" Tubing Head. The Tubing Head is equipped with HERCULES original overhead packing arrangement and self-aligning hinged slips, making this a simple yet complete hook-up, featuring safety with simplicity and minimum of parts.

AVAILABLE THROUGH ALL SUPPLY STORES

If you have any problems involving well head equipment, a phone call, telegram or letter will bring you the desired information — quick.

HERCULES TOOL Company

MANUFACTURERS OF OIL FIELD EQUIPMENT SINCE 1924

GENERAL OFFICES AND PLANT TULSA, OKLAHOMA

Export Representative: Oil Field Equipment Co., Inc., 30 Church Street, New York 7, N. Y.

John B. O'Connor of Dresser Industries spoke on the Russian turbo-drill at a recent meeting of the Dallas-Fort Worth chapter of Nomads, held at the Fort Worth Club. Shown with him are: Hank Davis, H. A. Davis Equipment Company; Bob Gilmore, DeGolyer & MacNaughton; O'Connor; Abbott Sparks, The Petroleum Engineer; Bob McLemore, Dresser; Lewis Foster, Foster Cathead Company.

THE OASIS—

A gathering spot for NOMADS

"Big Wigs" of the Dallas-Fort Worth Chapter golf tournament, held at the Ridglea Country Club in Fort Worth, June 15, are Jack Norton, Oil Center Tool, chairman of the golf party; Jim Riley, Brown Pipe & Machine, 1st prize winner; Maurice Finney, The Pure Oil Company, 2nd prize winner; Abbott Sparks, Petroleum Engineer Magazine, president of Dallas-Fort Worth Chapter of Nomads.

Nomads and guests attending the June meeting of Houston Chapter are: Seated, Alfonso Ramos, Hughes Tool Company of Mexico; A P. Berry, Socony-Mobil Oil Company; Ray Myers, Continental Supply; Dr. Don Chapman, Houston; W. D. Stico, Texas Gulf Sulfur. Standing, C. U. Posgate, Shell Oil Company; John Weber, Houston Tech. Labs; D. M. Brock, Garrett Oil Tools; R. E. Irby, Socony-Mobil Oil Company; John Munro, Applied Power Equipment; R. D. Walker, S. & R. Tool Company; S. D. Sands, Union Oil; C. W. Sternberg, Heidelberg Southern Sales Company; Frank Keightley, Asiatic Petroleum; and Rein Escher, Compana Shell de Venezuela.

here's how you "govern" the government

Much as we revere and respect this system of ours, we don't want the government running our lives.

The best government is one that's closest to the people. And there's just one way to keep it under control.

Vote.

Every time you get a chance.

Vote November 6, for sure.

Vote to elect the ones you want representing you. To keep the ones who are doing you proud. To get rid of the ones who are not so hot.

You're the boss, however you vote. No matter who's elected, you pay their salaries and paint their offices and keep watching over them as they work.

Even if the ones you're "agin" happen to win, they're obligated to the minority, too. They're servants of *all* the people, not just those who voted for them.

Your vote prods, approves, protests, demands, restrains, rewards.

Vote—so you and your children after you always can.

See You at the POLLS!

Nomads Meeting Dates and Secretaries

New York Chapter, first Monday, of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 4414, 30 Rockefeller Plaza, New York 20, N. Y.

Houston Chapter, second Monday. Ye Olde College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18161, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Jonathan Club, Los Angeles, California. Executive Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 4033, Tulsa, Okla.

Dallas-Fort Worth Chapter, first or second Monday. Secretary, H. A. Davis, H. A. Davis Power Equipment Company, 2142 Irving Boulevard, Dallas, Texas.

Houston Nomads meeting, June 11, at the Varsity Room of Ye Olde College Inn, Houston. Seated are: J. H. Grubb, Cameron Iron Works; Jack Morris (with cat), Venezuela; John E. Kunz, A. O. Smith Corporation. Standing: Bill Winder, Reed Roller Bit Company; K. P. Morris, Lee Construction Company; Joe Stroud, Fletcher Oil & Gas Company.

95 deg temperature didn't stop the New York chapter of Nomads from turning out for the Spring Golf Party, June 14, at the Baltusrel Golf Club, Springfield, New Jersey. Of the 130 members and guests attending the affair, the principal prizewinners were:

Above: E. E. Andreason, Andreason-Lundberg Corporation, high gross Nomad; A. V. Simonson, A. V. Simonson & Company, nearest pin Nomad; and H. Tait, National Supply Company, Inc., high gross guest.

Upper left: H. Leonard, Midwest Piping Company, low net guest; B. A. Warren, Esso Standard Oil Company, fewest putts guest; D. T. O'Connor, D. T. O'Connor, longest drive Nomad; H. Booth, Oil Well Supply, fewest putts Nomad.

Lower left: E. C. Herman, Esso Research, low net guest; J. Chanda, A. O. Smith Corporation, low gross Nomad; R. T. Meek, Ladish Company, low net Nomad (I. Frank Brown Memorial Trophy); and E. Ogden, Columbian Rope Company, low gross guest.

EVERY FIELD

OF ENDEAVOR

HAS PRODUCED

ONE

TOP PERFORMER

The greatest

race horse

of all time—

Man O' War

EVERY FIELD OF ENDEAVOR

HAS PRODUCED ONE TOP PERFORMER

In horse-racing it was Man O' War.

For smooth, free plunger operation under all kinds of pumping conditions it is

oilmaster

HARDENED AND HONED ONE PIECE PUMP BARRELS

Their design and general construction can, has and will be copied, but THIRTY YEARS OF EXPERIENCE and KNOW-HOW in this field of endeavor are the exclusive property of FLUID PACKED PUMP COMPANY.

oilmaster PUMPS
FOREMOST IN THE INDUSTRY

FLUID PACKED PUMP COMPANY
Main Office and Plant
Los Nietos, California

Distributed by The National Supply Co., Pittsburgh, Pennsylvania • Export: The National Supply Co., Export Division, 600 Fifth Ave., New York • Co-Distributors: Union Supply Company, Beacon Supply Co., Industrial Supply Co.

FREE REPRINT AVAILABLE
Reprints of the illustration of Man O' War without advertising sent on request

Speaker of the evening and international guests at the June 13 meeting of the Los Angeles Chapter of Nomads are: (standing) Jaime E. Reyes, Empresa Nacional del Petroleo from Chile; F. A. Woods, Shell from Borneo; C. H. Vincent, Shell from Borneo; Bill Allison, Aramco from Saudi Arabia; J. C. Green, Qatar Petroleum Company from Qatar; (seated) Fred Lay, D. & E. from Brazil; A. R. Little, Mene Grande Oil Company from Venezuela; Bill Bates, Shell Oil Company, guest speaker; Guy N. Rumbaugh Jr., Creole Petroleum Corporation from Venezuela.

Two new members were inducted at the June 13 meeting of Los Angeles Chapter of Nomads. Bill Brooks, Byron Jackson Tools, Inc. (left) is shown greeting Ray Elner of Kobe, Inc., new associate member, while Tom Martin, R. J. Eiche & Associates (right) will pin the Nomads lapel insigne on Lester Evans, Emsco Mfg. Company, new regular member. Tom Martin, ritual master, conducted the ceremonies, assisted by Bill Brooks, sergeant-at-arms.

"Mr. and Mrs. Party", an annual affair with the Tulsa Chapter of Nomads, was held June 29 at Southern Hills Country Club. The evening offered a cocktail party, followed by dinner, bingo games by the pool and musical entertainment. At the speaker's table (above left) were W. O. Timberlake, Lucey Products Corporation, deputy sergeant-at-arms; E. J. Handley, Midwestern Geophysical Laboratories, chairman, program committee; Melvin Heine, Phillips Petroleum Company, who presented an analysis of current trends in the U. S. economy with emphasis on the outlook for long-term financing of the oil industry; Don L. Collins, Republic Supply Company, president; John Pearce, Superior Iron Works & Supply Company, treasurer; and Guy F. Williams, Dowell, Inc., vice president. Others attending were: (above right) Mrs. Oscar B. Irizarry; Dr. Roberto Sarmiento, former president of the Colombian Petroleum Institute, Bogota, Colombia, now on the staff of Carter Oil Company Laboratories; Mrs. Sarmiento; and Don L. Collins, Tulsa Nomads president.

Russian turbo drill was the topic covered by John B. O'Connor, executive vice president of Dresser Industries, Inc., when he spoke before the Tulsa Chapter of Nomads on May 25. With him at the speaker's table were: Paul Hedrick, Tulsa World; A. E. Bradshaw, president, National Bank of Tulsa; M. L. Walraven, Jr., Walraven Company; Bill Timberlake, Lucey Products Company; O'Connor; Don Collins, Republic Supply Company; Andy Rowley, Tulsa Tribune; Guy Williams, Dowell, Inc.; and Blackie Hauser, agent.

Winners of door prizes at the 17th Annual Whing Ding of the Los Angeles Chapter of Nomads, Lakewood Country Club, July 13, are: (standing) Ed Peske, Baker Oil Tools, Inc.; A. B. Ellerman, Dresser Industries; L. P. Smith, Western Gulf Oil; Joe Bergeron, Jet-Lube, Inc.; Art Marshall, H. C. Smith Oil Tool Company looking over the head of Nancy Cameron, who drew the lucky numbers; Earle Moore, Loffland Bros.; Chas. Standfield, Fred E. Cooper, Inc.; L. A. Upshaw, Acme Precision Grinding Company; Ed Plaugher, equipment representative; (kneeling) Don Canavello, Globe Oil Tools Company; Hearn Paschall, Hercules Well Servicing Corporation; Chili Sutton, Oil Well Mfg. Company; Ken Langley, export representative; J. E. Mihm, Walworth Company. Not shown, Bob Gaylord, Wagner-Morehouse, Inc., who was busy dishing out the prizes.

Golf prize winners in the tournament of Los Angeles Chapter's Annual Whing are: (standing) Sid Hayes, Ball & Black Supply Company; Lefty Beeson, Specialty Sales Company; Ben Bayless, Lloyd Corporation; Ray Sparr, Parkersburg Rig & Reel; W. W. Bradley, Howard Supply Company; C. F. Van Loozen, Macco Corporation. (Kneeling) Knight Templeton, S. R. Bowen Company; Rex Collins, Hydril Company; Bill Huskey, Hillman-Kelley; John Robinson, Macco Corporation.

President's Trophy is presented to Lefty Beeson, (right) Specialty Sales Company, for Nomad low gross, by Harry Hester, McCullough Tool Company, president of the Los Angeles Chapter of Nomads, in the Annual Los Angeles Chapter Golf Tournament.

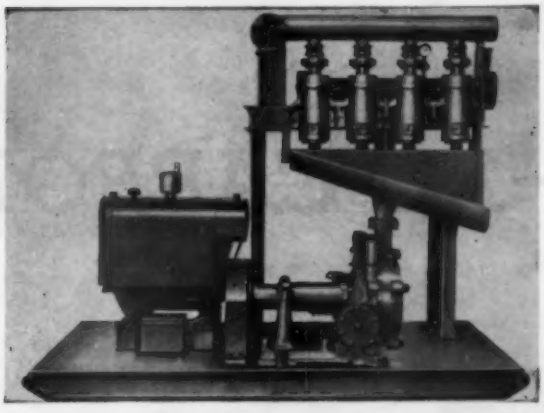
Moving to a New Address?

If you are moving or expect possibly to move any time soon, save the coupon below for your convenient change of address. It will prevent your copy of The Petroleum Engineer from being lost or misdirected.

TO: The Petroleum Engineer
P. O. Box 1589 • Dallas
CHANGE MY ADDRESS, beginning with the_____issue

FROM:_____

TO:_____



The DORRCO MUD D-SANDER

A new device for removing sand and abrasive solids from drilling mud.

- Up to 20% faster drilling
- Increases bit footage
- Greatly reduces pump maintenance
- Casing runs easier

For full information, write

SWACO

SALT WATER CONTROL, INC.
A Sid Richardson Development Company
1211 Ft. Worth National Bank, Ft. Worth, Texas

*More accurate than manual tank gauging

Type "C" Metering Separators are dependably accurate to 99.99%.

Metering Separator, with intergral metering chamber, separates well fluid into oil and gas, meters each. Liquid is metered by cyclic accumulation type positive displacement method. Free water can be separated, metered.

Use as test unit at tank batteries—eliminate separate test tank, manual tank gauging. Use on dual completed wells to eliminate 2nd tank battery. Install at wellhead for continuous metering, well production control. Measure production for royalties, taxes.

High metering accuracy accomplished by consistent liquid control, proper valving. Simple, accurate, reliable pilots react at same levels for non-varying unit volumes. Valves will not leak.

Write for Metering Separator literature today.

Type "C" Metering Separator*

SIZES AND CAPACITIES

Shell, O.D.	16"	20"	24"	30"	36"	48"
Length	6'-0"	8'-0"	10'-0"	10'-0"	12'-0"	12'-0"
Vol. Per dump BBLS.	¼	½	1.0	2.0	5.0	10.0
Max. Oil Metering Cap. Bpd.	288	500	720	1100	2000	3000

Available in 125, 300 and 600 psi w.p.

*Pat. Applied For

OIL METERING and Processing EQUIPMENT CORP.

MELROSE 5-1226 • 4843 YALE STREET
HOUSTON 18, TEXAS

Sales and service representatives in all major oil fields.

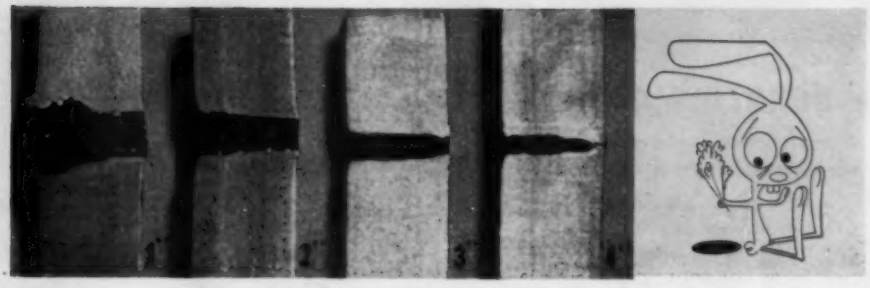
IT'S HERE

NOW!

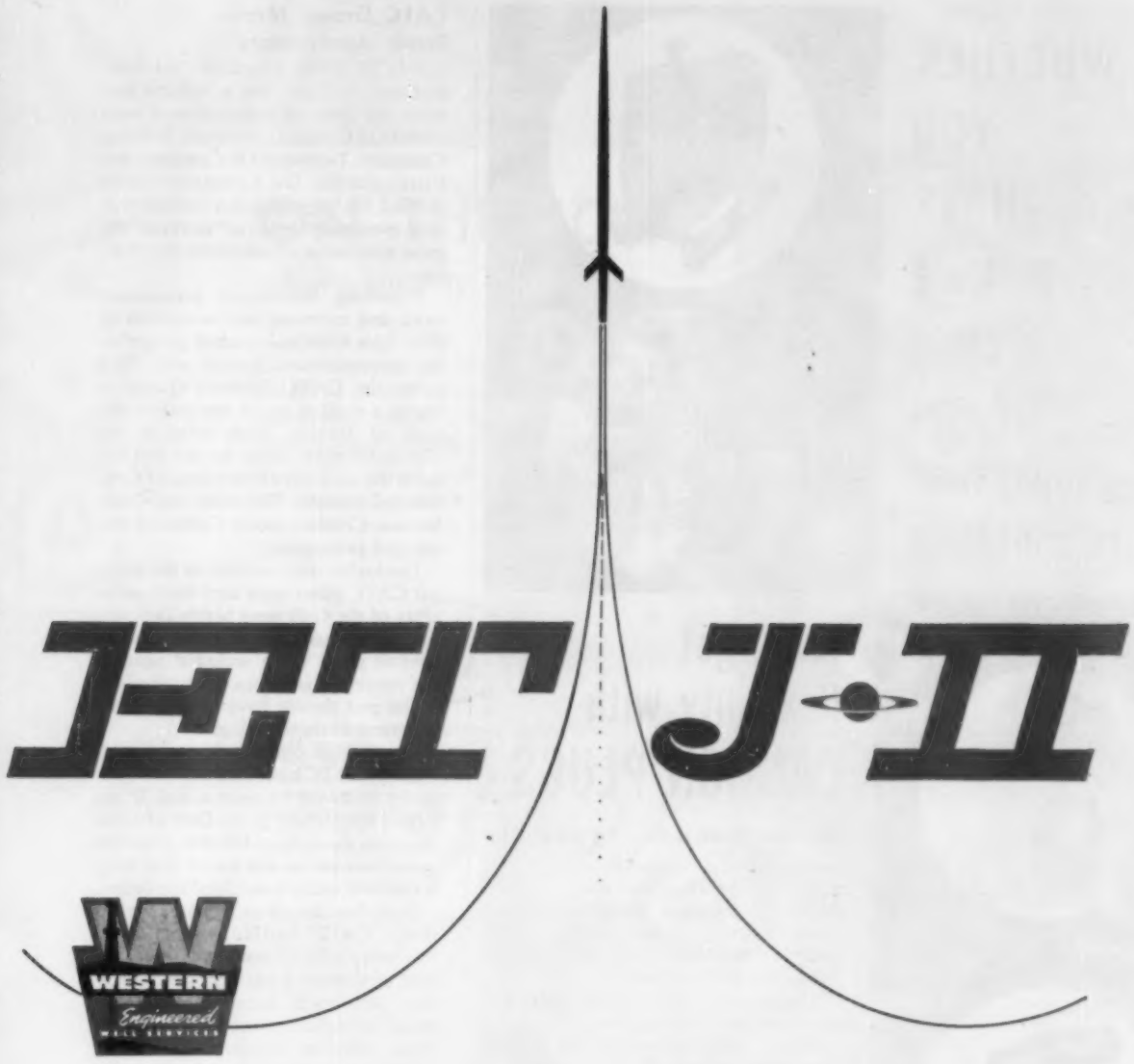
WESTERN'S

ROCK

ALL HOLE-NO CARROT



ROCKET J-II perforations are unobstructed to total depth — All hole and No carrot — plus ⅜" entry hole and 3.7" penetration in standard steel targets.



Jet perforating which does not form a carrot — which produces a larger entry hole — which gives more effective unobstructed penetration is NOW in the field, ready to serve you.

It's the *ROCKET J-II, a revolutionary development by Western Company research . . . thoroughly tested and proved under fire in standard tests supervised by the Perforation Investigation Committee.

ROCKET J-II is the superior answer in perforating. Ask your Western Company engineer **Today!**

THE WESTERN COMPANY

General Offices:
Midland, Texas

*Patent Pending

Texas: Odessa, Seagraves, Levelland, Snyder, Lubbock, Borger, Rankin

Oklahoma: Lindsay, Healdton, Okla. City

New Mexico: Hobbs

Kansas: Ulysses, Liberal

WHETHER YOU HAVE ... pumping engines or geophysical instrumentation

you'll get flexibility with CANNON PLUGS

More than 20,000 plugs ... big and little!

Cannon electric connectors are widely used throughout the petroleum industry. They're high in quality, rugged, provide the highest degree of reliability, flexibility, and convenience.

For power supply, engine starting, aerial exploration equipment, amplifiers, dynamic recording equipment, communication systems, seismographic equipment of all types ... you'll find none better. They increase operational efficiency wherever used.

Specify Cannon Plugs for replacement ... and be sure the original equipment you buy features Cannon Plugs. You'll be glad you did! They're also available thru Cannon Authorized Distributors.

Cannon Plug Guide will give you a survey of all the connector line.

CANNON PLUGS

CANNON ELECTRIC

please refer to dept. 435

Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, California. Representatives and distributors in all principal cities from coast-to-coast.

Eight plants around the seven seas!

CATC Group Marks Tenth Anniversary

July 29, 1946, a typically hot summer day in Texas was a historic moment for four oil companies—Continental Oil Company, Atlantic Refining Company, Tidewater Oil Company and Cities Service Oil Company — and marked the beginning of a venture that will eventually help to increase the great storehouse of petroleum in America.

Following months of preliminary work and meetings, representatives of these four firms had reached an operating agreement and formed what they called the CATC Offshore Group to search for oil in a vast expanse of the Gulf of Mexico. Each letter in the alphabetic name stood for the first letter in the successive firm names of Continental, Atlantic, Tidewater and Cities Service. Continental Oil Company was selected as operator.

Geologists who worked on the original CATC plans were convinced some areas of the Gulf were highly prospective, with possibilities of many productive oil pools being secluded beneath the veneer of salty sea. Developments in the past decade have confirmed the judgment of these geologists.

On the date marking its tenth anniversary, CATC has 43 oil and gas wells in 14 fields off Louisiana and is the largest leaseholder in the Gulf of Mexico, with more than 400,000 acres. Its operations are so fast-paced that what is reported today is outdated tomorrow.

In its first decade or "shakedown period," CATC battled almost overwhelming odds to overcome such hazards as wretched weather, treacherous seas, salt water corrosion and crippling legislation. Some of these still cause kingsize headaches. But the Group's greatest fight today is being waged against zooming operating costs.

CATC discovered early that offshore safaris can sink a super-size bankroll. In ten years, the Group has risked a fabulous $102,000,000 in its offshore venture. It is estimated that the entire petroleum industry has invested more than $1.3 billion in the offshore gamble and has received in revenue less than one-fifth of that amount — leaving a gross deficit of some $1 billion. Some $5,000,000 has been shelled out by CATC for geophysical work alone ... another $43,000,000 for the Group's tidelands leases.

Today it requires more than $400,000 to drill an average offshore well, about six times as much as an inland well. A few tidelands wells have cost more than $1,000,000. Monthly offshore expenditures of the oil industry, exclusive of lease bonuses and rentals, are running around $18,000,000.

ON THE JOB

where quality pays off...

The man on the job buys a valve for a specific use because he knows from experience that the valve will get the job done. He knows the valve offers the best design, construction and materials to meet known operating conditions. He buys a valve with all the qualities required by a specific use. For many years thousands of men in the field have selected ORBIT valves because they have the kind of **quality** that pays off on the job!

ORBIT VALVES

HOUSTON, TEXAS 407 Velasco (Serving the Gulf Coast)
CASPER, WYOMING
247 West First Street
(Serving the Rocky Mountain States and Canada)
ODESSA, TEXAS 402 West County Road (Serving West Texas)
EXPORT REPRESENTATIVE: 500 Fifth Ave., New York 36, N. Y.
Ph. BRyant 9-2236
CANADIAN REPRESENTATIVE: 536 8th Ave. West, Calgary, Alberta, Canada Ph. 3-0437

"Here comes your QD Sheave—the original two-piece design."

Did we say quick delivery!

Hope to tell you we said quick delivery. Meant it, too. On Worthington QD sheaves and Worthington-Goodyear V-belts the delivery you get couldn't be quicker.

QD stands for Quick Detachable—a perfect monicker for the original two-piece sheave because it's so easy to get on and off the shaft—holds tight, too.

And when you're using QD sheaves and V-belts you've got no supply problem. Your Worthington distributor (or local supply store) stocks most sizes—can get others rushed from nearby warehouses. Call him today and say Worthington "QD"—for Quick Detachable and quick delivery. MV-4-4

WORTHINGTON

Buy These Worthington Standard Products From Your Local Distributor

COMPRESSORS • PUMPS • MULTI-V-DRIVES • VARIABLE SPEED DRIVES

B-130

BOOKS ★

Structural Geology for Petroleum Geologists, *by William L. Russell, published by McGraw-Hill Book Company, 330 West Forty-Second Street, New York 36, New York. Pages, 427. Price, $7.50.*

Author of this volume, professor of geology at Texas Agricultural and Mechanical College, has eliminated all topics that, though usually included under structural geology, have no actual relation to oil work, such as igneous and metamorphic rocks. Conversely, topics not ordinarily subsumed under structural geology, but of value to the petroleum geologist, such as reversed drag along faults and structural control on sedimentation, are discussed in detail. The book was intended to be used as a textbook for graduate and undergraduate courses in structural geology, and as a reference book for petroleum geologists. Emphasis is placed on structural types and processes, rather than on detailed descriptions.

Ira Rinehart's 1956 Yearbook, *compiled by Rinehart Oil News Company, P.O. Box 1208, Dallas, Texas. Pages, double-volume, 559. Price, double-volume, $35.00, to non-subscribers.*

Following the same editorial format as previous editions, this annual reference work in two volumes contains complete 30-acre coverage of last year's major discoveries, important extensions, and significant dry wildcats, supplemented with state, field and area maps, and summary information on regional trends.

Approximately 2,055 discoveries and step-out wells, and 579 influential failures are detailed as to name, location, completion date, producing zone, producing interval, official gage, elevation, formation tops, total depth, casing points and other pertinent historical material.

Often called the industry's greatest single source of operating information, the double-volume publication is also offered to the firm's regular oil report subscribers at a rate of $25.00 per set.

Economic Geography of Industrial Materials, *edited by Albert S. Carlson, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages, 494. Price, $12.50.*

Written by top experts in a wide range of key industries, this fact-filled handbook is said to answer a great many perplexing problems that industry must face in today's ever changing atmosphere. It is of value not only to producers of chemicals and manufactured goods but also a broad range of workers in finance, investment, labor relations, housing and civic development as it sets forth the essential problems involved in the economic geography of a large cross section of industrial manufacturing.

Packed with maps, tables, charts and statistics, each chapter describes economic-geographic conditions necessary for profitable production. Such factors as location, climate, soil, topography, water resources, minerals, fuels, labor, capital, management, transportation and markets are discussed and evaluated to show profitable trends and conditions at present and in the future. Each factor was carefully studied and appraised by the company, trade association or individual who wrote the chapter involved.

Part I, chapter one, provides a description of the world distribution of the basic resources and population, and of the economic and demographic conditions under which all industry operates.

Handbook of Oil and Gas Law, *by Robert E. Sullivan, published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, New York. Pages, 556. Price, $11.35.*

Intended for those interested in the legal aspects of the oil and gas industry, this handbook is of vital importance to lawyers, landowners, lease brokers, oil company personnel, legislators in states where conservation laws are under consideration, and to everyone who needs perspective in all phases of oil operations. It is a clear, intelligible discussion of the basic principles of oil and gas law, how these principles have been developed, and their application in the light of present-day operations.

The author has concentrated on two segments of the oil industry — production and transportation — with greatest emphasis upon production and the legal problems connected with it. Here is found a full discussion of aspects of taxation and financing peculiar to these branches of the industry. To provide an understanding of the basis for the legal concepts that have evolved, an introductory chapter has been included on geology and petroleum engineering principles.

Thoroughly illustrated with suggested forms and clauses for most of the usual oil and gas documents, the book was written to be understood by all those concerned with these important questions. It incorporates illustrative instruments, solutions to common problems, and suggestions for specific ways in which frequently occurring problems can be solved.

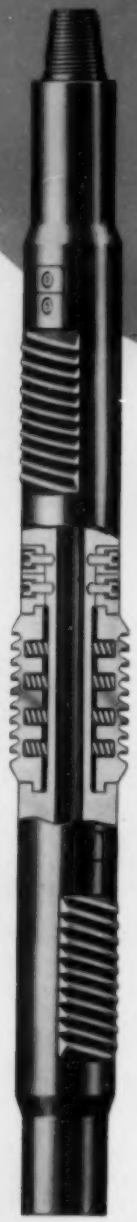
GRANT

GRANT
OIL TOOL COMPANY

No. 3 of a series on how Grant specializes in just one job: Engineering the tools that help you drill wells better!

here's why

Casing Strings Cleaned by the Grant Casing Scraper are CLEAN



Casing Scraper

CHANCES ARE, *any* string of casing you run, cement or perforate is a string that *must be clean* before you set packers, run swabs or perform any other completion work on new wells or old.

With the Grant Vertical Casing Scraper on hand for either new well completions or work-over jobs, you're equipped with the tool that's specifically engineered to clean casing *clean*. **Here's why:**

You can run the Grant either on a string of tubing or drill pipe, or on the wire line. On tubing or pipe, you can scrape vertically or rotate to scrape if desired. You can drill out and scrape simultaneously by installing a bit on the bottom of the scraper, with full circulation at all times. On the wire line you can use a spudding action to clean the entire string.

You get more cleaning action than with any other tool. Three sets of spring-loaded cutters are so spaced as to more than cover the entire casing circumference, yet spacing is engineered for unrestricted circulation.

You get easier and more efficient scraping. Numerous cutting edges of tungsten-carbide contact the casing under controlled pressure, and are helically designed for efficient removal of cement, mud cake and bullet burrs without cutting the casing—*whether you rotate to scrape, or scrape vertically.*

You have an economical scraper, because a single tool scrapes all weights of the casing through which it will run. Cutter changes—if required—are no trouble at all, yet cutters are securely locked against loss in the hole.

Model 1540 Wall Scraper | Underreamer | Cushion Stabilizer | Drillblade Stabilizer | Model 6400-A Reamer Near Bit Type

All in all, the Grant is your best bet for well completion work, and its use is top protection for future development of the well. Grant Scrapers are available for all casing diameters from 4½" to 11¾", all weights. ***Write for Bulletin 59—or ask your nearby Grant service man for details!***

GRANT

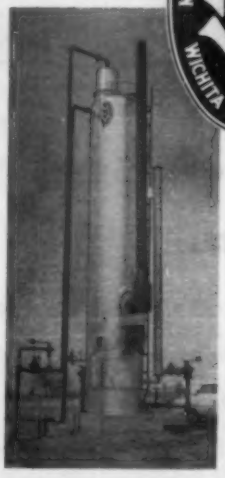
OIL TOOL COMPANY

Home Office: 1702 East Vernon Avenue, Los Angeles 58, California

Be **SURE**
of Trouble-Free
Performance

Specify . .

MFD BY M&V TANK COMPANY
M & V
WICHITA FALLS, TEXAS



TYPE P-V
PRESSURE TREATERS

M & V Pressure Treaters have an unbeatable record of trouble-free performance. They are designed to operate automatically with a very minimum of supervision . . . built to the most exacting standards . . . and offer you the finest possible assurance of full recovery at lowest cost.

MFD BY M&V TANK COMPANY
M & V
WICHITA FALLS, TEXAS

Steel Fabrication for the Oil Industry

Yemen, Arabian Exploration Activities Accelerate

Reports stemming from the small country of Yemen, south of Saudi Arabia, and from Saudi Arabia, indicate several accelerated programs of exploration are currently in progress.

German and U. S. interests appear to have settled a disagreement over a Yemen Government oil concession. C. Deilmann Bergbau GmbH, Bentheim, Germany, has relinquished its contract for an exploration concession after two years search for oil deposits on the coast of the Red Sea. Yemen Development Company, U. S. organization which last year signed a 30 year concession agreement with Yemen, has obtained clear title to its concession according to John A. Crichton, executive vice president. The German firm had done gravitymeter work, according to a news release, and had shipped part of a drilling rig to a location for the first wildcat.

The discovery of oil in a wildcat well on the Persian Gulf coast was announced recently by the Arabian American Oil Company. The wildcat, known as Kharsaniya Well No. 1, is located approximately 80 miles northwest of Dhahran, Aramco's headquarters. It is the first well to be drilled on the Kharsaniya structure. In a drill stem test of the top part of the Arab zone between 5954 and 5976 ft, the well flowed at a rate of 2200 bbl per day, with a surface pressure of 800 psi and a gas-oil ratio of 340 to 1. The oil was sour and had a gravity of between 32 and 33 deg API. Operations are continuing to evaluate the discovery.

Work has begun on the small island of Das, in the Persian Gulf 60 miles from the mainland, to make a base camp for drilling an underwater deep test well at Abu Dhabi Marine Areas Ltd., in which The British Petroleum Company has a two-thirds shareholding and the Compagnie Francaise des Petroles one-third. The site of the deep test well is some 20 miles off the island of Das. This will be Abu Dhabi Marine Areas' first deep test well in the Persian Gulf, following several years of geological and geophysical surveying of the seabed off the coast of Abu Dhabi. To drill the well, a barge mounting a drilling rig capable of reaching a depth of 15,000 ft is being built and will be towed to the Persian Gulf. The total cost of the whole operation, up to the completion of the deep test well, is estimated at about $14,000,000.

Call for
K & G
Magnetic Fishing Tools
for fast, efficient fishing

4071

In sizes 1¾" through 11½"
Available through most fishing tool companies.

K & G
OIL TOOL AND SERVICE COMPANY, INC.

2703 Sackett Street • Houston 6, Texas
Jackson 2-5436

Branch Offices: CALIFORNIA: Avenal, Bakersfield, Long Beach, Los Angeles, Ventura • ILLINOIS: Olney • KANSAS: Great Bend, Liberal • LOUISIANA: Lake Charles, Jennings, New Iberia, Houma, Harvey • NEW MEXICO: Farmington, Hobbs • OKLAHOMA: Healdton, Oklahoma City • TEXAS: Abilene, Andrews, Bay City, Beaumont, Borger, Brownfield, Corpus Christi, Edinburg, Houston, Kilgore, Odessa, San Angelo, Sherman, Snyder, Victoria, Wichita Falls • WYOMING: Casper.

Perforating Study Finishes First Year

A unique organization of the petroleum industry, the Perforation Investigation Committee, completed its first year of operation in July.

Established as an impartial group to test performance of perforating tools of the various companies, the organization recently published for participating members a volume of actual test results conducted during the past year.

Perforating, widely used in oil well completions to control the producing reservoir flow, is a specialty of several of the service companies, and is offered by nearly all the well service firms.

Nine of the service companies are members of the committee, as well as 15 major producing companies who sponsor the project. The PIC was established through the efforts of R. J. Bethancourt, petroleum engineer of Sun Oil Company. He has served as chairman of the group through its first year of operation.

Bethancourt was presented a gold watch by representatives of the service company members at a luncheon session at Dallas in May.

Plans for the PIC, presently operating in the Southwest, call for its continuation on a national scale by the API.

Testing of perforating tools of the service companies came about as a result of a need for accurate performance data of the various perforating tools and their uses.

Begun in Dallas, the PIC plan was adopted by the 15 producing companies and the service companies, which represent 95 per cent of the perforating action in the oil industry. Representatives of the companies comprise the committee, which conducts and records results of the tests.

During the first year of operation, members of the committee tested some 60 different perforating instruments. A standard testing procedure was established, with verification of test results coming from a minimum of three observers, representing the production companies.

Tests have been conducted at various sites — Arlington, Midland, and Houston, Texas, and Duncan, Oklahoma.

Results of the tests are published in a loose leaf type binder, with actual reproductions of test result sheets from the test sites used, plus photographs of many of the targets after use.

Established from the targets are data considered important to the performance of the perforating instruments — entry hole size, total depth of penetration, burr height and probe depth. Firing of the perforating tools is conducted to PIC specifications.

PIC restricts use of the material in the book to the participating companies, and advertising of the results on a comparison basis is forbidden. Only results of the advertising company's tests may be publicized.

Participating service companies include Dowell, Inc., Halliburton Oil Well Cementing Company, Lane Wells Company, McCullough Tool Company, Perforating Guns Atlas Corporation, Ram Guns, Inc., Schlumberger Well Surveying Corporation, Welex Jet Services, Inc., and The Western Company.

Producing companies participating are Anderson-Prichard Oil Corporation, The Atlantic Refining Company, The British-American Oil Company, The Chicago Corporation, Continental Oil Company, Gulf Oil Corporation, Scott Hammonds, Lone Star Producing Company, The Pure Oil Company, Republic Natural Gas Company, Seaboard Oil Company, Shell Oil Company, Southern Production Company, Sun Oil Company, and The Texas Company.

Production Research Set At Harmarville, Pa.

GULF Research & Development Company revealed that it has undertaken an expanded production research program, to be conducted by 150 scientists, engineers and technicians, in an effort to improve the recovery of petroleum from oil fields.

Specific aims include increasing the percentage of petroleum recovered from oil formations, and bettering both the speed and the economy of drilling wells, producing and transporting oil and gas.

Two new buildings, to cost approximately $1,500,000, will house these activities, for which additional staff members are now being recruited. Both will be begun this spring. The smaller, for heavy drilling research, is scheduled for completion in August and the main building in January, 1957.

The larger structure, of two-tone brick and steel frame, will be four stories high and 227 ft by 53 ft in dimensions. It will include some 94 laboratories and offices, besides storage, utility and service rooms.

The latest in chemical laboratory and mechanical equipment will be provided. The building will be completely air-conditioned, fluorescent-lighted and plaster-walled. The building will stand in a tree-lined quadrangle of the 53-acre laboratory grounds.

Underground passages will connect it with the other chief laboratory buildings.

The smaller structure, of concrete block and metal panels, 61 ft by 56 ft in dimensions, will be built around an 80 ft oil well derrick mounted on a 13 ft platform in a 28 ft high bay. Sliding roof panels will permit opening the bay for derrick operation.

There will be a single floor, several offices, and a mud pit for mixing drilling mud. The area beneath the drilling platform is designed for setting up heavy test equipment, such as experimental drills and oil field rock cast in concrete for drilling rate studies.

"The importance of the program in which these facilities will be used," said Dr. Blaine B. Wescott, Gulf Oil vice president, research, "is evident from the fact that any progress in upping petroleum recovery will increase the nation's usable oil reserves.

"While it would be foolhardy to think we will ever drain every drop from an oil field, modern research promises to bring us closer to this condition than once considered possible.

The staffs which are tackling the assignment include scientists and engineers with degrees in chemistry and physics, and in mechanical, electrical, chemical and petroleum engineering, plus trained technical assistance. Target for achieving full staff strength is 1958.

Reservoir mechanics will concentrate on improving the overall recovery from oil fields. It will study the behavior of oil reservoirs, the flow of oil and other fluids underground, gas and water drives, and thermal recovery methods.

Production engineering will seek to improve the drilling of wells and the utilization of pipe lines. It will study how to increase production through the application of mechanical, hydraulic and chemical methods, and more efficient pumping and fluid handling.

Southwest

HEAVY DUTY PACKAGED GAS COMPRESSOR FOR UNDER 250 H. P.

COMPLETE —
Engine, compressor, scrubbers, cooling and lubricating systems and controls mounted on a floored skid. Components are of the same quality as are found on Southwest's large packaged plants.

RUGGED —
The slow speed (300 rpm), given this Cooper-Bessemer FWP compressor the overline needed for continuous operation. Heavy duty poly V-belt drive, 300 H.P. per frame, oversize bearings, are other examples of traditional Cooper-Bessemer quality.

ENGINEERING —
Southwest engineers have designed and built the best low horsepower packaged compressor. It is the rugged, high quality unit in the field.

Here is the heavy duty gas compressor the industry has needed. Not a stripped down model, but a rugged packaged plant designed and built with the same thoroughness that Southwest puts in its larger units. The Cooper-Bessemer compressor cylinder has interchangeable liners and is interchangeable with larger compressors. The same vertical air discharge cooling is used as in integral packaged gas compressor plants. The engineering design features proved by Southwest in integral units are incorporated in this, the first quality packaged gas compressor in the low horsepower field.

FOR GAS LIFT, GAS BOOSTER, PRESSURE MAINTENANCE AND SIMILAR PROJECTS.

SOUTHWEST INDUSTRIES, INC.

Post Office Box 7773, Houston 7, Texas

New Offshore Drilling-Contracting Firm

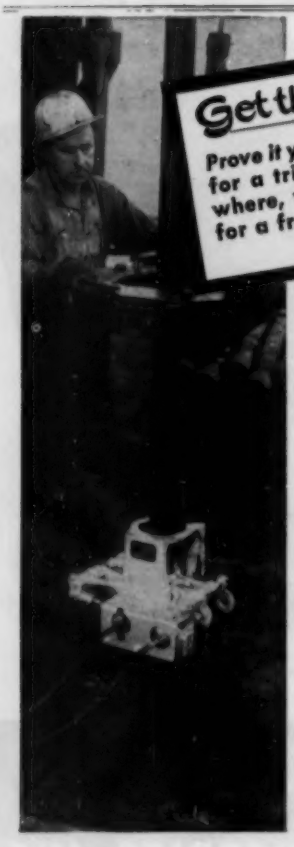
Coastal-Marine of Houston contracts for two vessels and complete rig totaling $3,500,000 to be ready for work next year. Other units planned.

Offshore equipment being constructed for Coastal-Marine. The complete rig, 2500-ton drilling tender and 297-ton cargo-supply ship to cost $3,500,000. Both vessels are self propelled.

FORMATION of Coastal-Marine Drilling and Construction Corporation, an offshore-drilling construction firm, has been announced by Howard S. Cole, Jr., president, who for many years was a Texas Company producing department executive, subsequently a drilling contractor in the U. S. and Venezuela, and more recently a well known Houston independent operator.

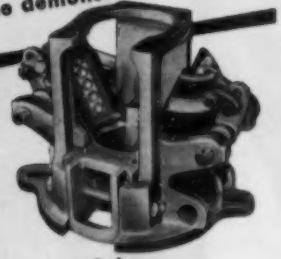
The new corporation has already negotiated agreements with New York Shipbuilding Corporation of Camden, N. J., and Dresser Industries, Inc., of Dallas, Texas, to provide a specially designed, self-propelled drilling tender, complete drilling rig, and a cargo vessel at a total cost in excess of $3,500,000.

Prominent in the organization of the new firm, which will specialize in drill-



Get the best by test!

Prove it yourself—use the ADVANCE for a trial period, anytime, anywhere, without obligation. Write for a free demonstration.

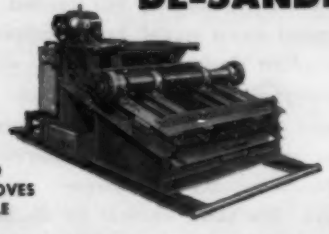


Advance
air powered
TUBING SPIDER

The ADVANCE is the first and only complete Automatic Air-powered Tubing Spider. It is also available for hydraulic operation. It is full of features that you'll not find in any of its imitations.

Advance
OIL TOOL CO.
2853 Cherry Ave.,
Long Beach 6, Calif.
Garfield 485-64
Mid-Continent Rep: Hillman-Kelley
Export Rep: Roland E. Smith

ALWAYS IN OPERATION
WHEN PUMPS ARE RUNNING
NEW MODEL RUMBA
DE-SANDER



ALSO
REMOVES
SHALE

HUTCHISON MANUFACTURING CO.
6609 AVENUE U HOUSTON 11, TEXAS

ing on the continental shelf in the Gulf of Mexico are other prominent Gulf Coast oilmen. They include:

Irwin W. Alcorn, pioneer in marine drilling operations with The Pure Oil Company, who will serve Coastal-Marine as vice president, director and general manager;

David G. Hawthorn, senior partner of Petroleum Consultants, top-ranked geological and petroleum consulting firm of Houston, vice president and director of Coastal-Marine;

Hugh Q. Buck, partner in the law firm of Fulbright, Crooker, Freeman, Bates and Jaworski and a specialist in petroleum industry law, who will be secretary and director of the new offshore drilling firm;

Hurley C. Roberson, senior partner of the Houston accounting firm of Hurley C. Roberson & Co., with a background in oil and gas accounting and tax matters, treasurer and director of Coastal-Marine;

John N. Donhaiser, production engineer with The Pure Oil Company and for the last five years concerned primarily with drilling and production activity in the Gulf of Mexico, who will be assistant manager (technical) of the new contracting company;

Troy Barnett, formerly in charge of Gulf Coast and offshore drilling operations for Phillips Petroleum Company and more recently vice president in charge of operations for Foster Drilling Company, will be assistant manager (operations) for Coastal-Marine; and

Lowell B. Christenson, president of Christenson and Graham, Inc., consulting engineers and naval architects of Pasadena, Texas, which firm will be marine consultants for the new corporation.

Members of the board of directors, in addition to the officers listed above, will include Houston oilmen and financiers David C. Bintliff and H. J. Mosser as well as J. M. Jones, partner in the New Orleans law firm of Jones, Walker, Walchter and Poitevent and chairman of the executive committee of Southdown Sugars.

Alcorn, Donhaiser and Barnett will devote full time to the development and operation of Coastal-Marine. * * *

Howard S. Cole, Jr., president of Coastal-Marine.

Irwin W. Alcorn, vice president, director and general manager.

Only **SPANG** can give you the best in *Strength, Service, Economy and Footage* in a Prosser-type

SWIVEL ROPE SOCKET

There are times when an ordinary rope socket will meet your needs. But there are too many times when you can't afford to risk trouble—when you require a rope socket that's precision made and utterly dependable under all conditions. This is the time you'll be glad to have a Spang Rope Socket on the business end of your string—

. . . AND HERE'S WHY SPANG'S BEST

■ Completely Heat-Treated for maximum toughness and hardness ■ Precision machined ■ High steel strength ■ Extra strong joint ■ Carefully finished inside bore ■ Perfect setting for cable ■ Socket neck grooved for the use of fishing tools ■ Made by the country's oldest and largest manufacturer of cable tools

FIRST CHOICE OF DRILLERS EVERYWHERE

SPANG & COMPANY

DEPT. O-7 BUTLER, PENNSYLVANIA

For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.

EXPLORATION ACTIVITIES

MISSISSIPPI

★ Four wells have been slated for drilling in Issaquena County beginning before September 1 by Sinclair Oil and Gas, Vaughey & Vaughey and Donald M. Reese. The wells are to be drilled on a 17,000 acre lease spread out of a larger area put together by the two Jackson, Mississippi independents. Sinclair will get a half-interest for drilling the wells. Vaughey & Vaughey and Reese made a deal with Amerada Petroleum for a half-interest in 28,000 acres for a seismograph survey of the holdings, and negotiations are now in progress for 10,500-ft Smackover Test. The spread includes 22,000 acres of the Delta wildlife and forestry lands, comprising most of 2 townships east of Valley Park.

COLORADO

★ New Drilling Company has tested its Denver-Julesburg basin discovery, its No. 1 Smith, located 1¾ mile northeast of the Last Chance field in Washington County. Well was perforated in the "J" sand at 4948-51 ft. Crews swabbed 48 bbl of oil per hour for four hours on initial test; operators are setting pump.

★ Shell Oil Company has shut in its gas discovery in Weld County and begun a confirmation test 2½ miles south of the Battle Canyon field. The discovery, the No. 1 Lobb, was drilled to 5979 ft, perforated at 5916-32 ft in the "J" sand. The well tested 4,100,000 ft of gas a day.

TEXAS

★ Center of East Texas activity, the British-American No. 1 Bessie Wisenhunt in Wood County was given its first full 24-hour gage late in July. The Woodbine sand find, on the Hainesville dome six miles northeast of Mineola, produced 179 bbl of oil through a 11/64-in. choke under 850 psi tubing pressure. The well was opened on a ⅜-in. choke and flowed for 15 minutes through that opening to make 5.75 bbl with tubing pressure of 500 psi before the choke was changed. Oil came from perforations at 9217-22 and 9228-47 ft.

★ A sixth pay, the San Andres, has been opened in the Tippett field of northwest Crockett County, 10 miles south of McCamey. The discovery, the Theiss Drilling Company of Fort Worth No. 2 Mayberry, was completed for a 24-hour pumping potential of 72.08 bbl of 26 deg oil through perforations at 2854-66 ft.

★ Humble Oil's J. L. Atkins No. 1 is now rigging up 3½ miles west of McKinney, Texas, on the John McGarrah survey. The wildcat well has been projected to 12,000 ft. Drilling contract has been awarded to Falcon Seaboard Drilling Company, Tulsa, which is moving in with its rig No. 24. The well is directly north of Love Field, Dallas. It is one of the most "metropolitan" wells recently wildcatted in North Texas, since it is located almost in the suburbs of both McKinney and Dallas.

★ A new producing horizon for the West Seminole field of Gaines County, Texas, is indicated at the Cities Service-Atlantic Proctor No. 9 test. In a drillstem test opposite the Leonard formation between 8722 and 8786 ft, 120 ft of oil and 480 ft of oil-and-gas-cut mud were recovered in 6 hours. Initial bottom hole pressure was 170 psi, rising to 475 psi at the end of the test. Contractor is drilling to the Ellenburger, expected at 13,000 ft. The Proctor No. 9 test is approximately 2.5 miles southeast of the company's Corrigan No. 1 discovery which was completed in the Leonard formation. A confirmation to the Corrigan discovery flowed 106 bbl of 36.5 deg oil in three hours.

★ Confirmation of a newly-discovered Dornick-Hills Sand field is indicated by Nortex Oil & Gas Corporation No. 1 J. Crossman. Well, in Grayson County, cored 16 feet of productive Dornick-Hills Sand from 6512 to 6526 ft. Possibilities of dual pay development are indicated by recovery on drillstem test in the Foster Sand from 6363 to 6375 ft of 310 ft of mud-cut oil on one hour test with bottom hole flowing pressure zero and bottom shut-in pressure of 2700 psi in 20 minutes. Additional pay zone was indicated by electric log in Strawn section from 6040 ft to 6054 ft. Discovery well for the new Dornick-Hills field was the Nortex Oil & Gas Corporation Roy Jewell No. 1 well located 660 ft east of the new producer.

CUBA

★ An oil discovery has been completed in the Central Basin by the Cuban American Drilling & Exploration Company, production subsidiary of Cuban American Oil Company. The well, the No. 1, Catalina, is about eight miles south of the Jatibonico field. It produced 25 bbl of 35 deg oil in a 50 minute drillstem test through a ¼-in. choke from 7100 to 7137 ft. No flowing potential has yet been established.

ARIZONA

★ El Paso Natural Gas Company has staked a projected 7000 ft wildcat southeast of the East Boundary Butte area in Apache County. The No. 1 Bita Peak is spotted six miles southwest of Humble Oil & Refining's recent discovery, the No. 1-B Navajo, which flowed 369 bbl of oil and 55 bbl of water per day.

CALIFORNIA

★ Bandini Petroleum has brought in a 650 bbl per day wildcat producer in the Devils Den area of Kern County. The well, the University of California No. 3, flowed through a 16/64-in. choke from the 3550 to 3640 ft level. Oil is 45 deg gravity. Production has been cut back to 150 bbl a day until storage tanks are set.

LOUISIANA

★ Completion of an important wildcat discovery in the Gulf of Mexico, on Federal Lease Block 175, Eugene Island, 40 miles offshore from the coast of Louisiana, is announced. The prospect is owned by Peoples Production Company, a subsidiary of Peoples Gas, and Sinclair Oil and Gas, Sohio Petroleum, and El Paso Natural Gas Company. Sinclair, operator of the well, drilled to a total depth of 13,004 ft, but plugged back and perforated with 32 shots from 11,830 to 11,838 ft, in the massive sand section. On a 12-hour test, the well flowed steadily at the rate of 417 bbl per day through a ⅛-in. choke. Gravity of the oil is 37 deg and the gas-oil ratio is 1275 to 1 with the flowing pressure 4400 psi. This operation was conducted in 87 ft of water from a self-contained platform located at a distance of 70 miles from a land base in Morgan City, Louisiana.

VENEZUELA

★ President Marcos Perez Jimenez, in the official gazette, has announced that the Venezuelan Government is considering applications for new petroleum concessions in six areas of the Lake Maracaibo area. The total area to be granted for exploration exceeds 43,000 acres of surface in Lake Maracaibo. Companies now operating in Lake Maracaibo are producing 1,300,000 bbl daily, and there is expected to be keen competition between them and other American or European companies for the new concessions. This is the first time since 1945 that Venezuela has considered additional oil concessions.

Comprehensive core analysis data immediately required for drilling and completion operations is best obtained from properly preserved (quick-frozen) samples.

But the scope of additional information obtainable later from "warehouse" as well as from preserved cores is virtually limitless for application to calculations of primary and secondary recovery.

Unlike routine core analyses usually performed on a per-well basis, special core analysis data are generally applicable to an entire field problem. In addition to this significant economical aspect, the original cost of coring is minimized by broadening the scope of reservoir information from cores already accessible at the surface.

Take an average day in Core Lab's Special Core Analysis Studies Section. You'll find expertly trained engineers developing critical data (see below) on cores from reservoirs located throughout the world—Iraq, Canada, Kuwait, Venezuela, The United States.

Think twice before you send old cores to the junk pile. They've still got a big story to tell.

SPECIAL CORE ANALYSIS SERVICES

Water Flood Susceptibility, Water Permeability, Restored State Flood, Oil/Water Relative Permeability, Gas/Oil Relative Permeability, Capillary Pressure, Formation Resistivity, and various other measurements for use in individual field problems.

For a set of six bulletins describing the above services, send request on your company letterhead to Core Lab, Box 10185, Dallas.

CORE LABORATORIES, INC.

801 CORE STREET, DALLAS, TEXAS

CORE LAB

PETROLEUM RESERVOIR ENGINEERING

DALLAS, FT. WORTH, HOUSTON, CORPUS CHRISTI, McALLEN, SAN ANTONIO, MIDLAND, ABILENE, PAMPA, MONAHANS, LUBBOCK, LOVINGTON, SHREVEPORT, TYLER, EL DORADO, OKLAHOMA CITY, WICHITA FALLS, TULSA, ARDMORE, BARTLESVILLE, LIBERAL, ARKANSAS CITY, GREAT BEND, LAFAYETTE, NEW ORLEANS, HATTIESBURG, DENVER, STERLING, CASPER, WORLAND, KIMBALL, NEBR., FARMINGTON, BAKERSFIELD, LONG BEACH, CALGARY, EDMONTON, REGINA, VENEZUELA, S. A.

ARIZONA

★ Falcon Seaboard Drilling Company and Associates, Tulsa, Oklahoma, has scheduled a 5000 foot wildcat well on the Antelope Springs Structure in Mohave County, 15 miles south of the old Virgin oil field in Washington County, Utah. Location of the Government No. 1 will be in the southeast quarter of the southwest quarter of Section 28, Township 40 North and Range 8 West, Salt Creek Meridian. Foremost objective is production in top of the Mississippian formation. But drillers hope for good bets in Upper Kaibab, Moenkopi and Coconino formations. Antelope Structure, which has never seen a conclusive test, is on the east side of the big Hurricane Fault and on the other side of that fault from the Hurricane Structure. It is expected that tools will be moved to the new location within the next 30 days.

MONTANA

★ The British-American Oil Producing Company's second producer in North Clark's Fork extends the field to the northwest. Its Montana State Well No. 2 located in Carbon County, Montana, showed considerable promise when a drill stem test was made from 8980 ft to a total depth of 9043 ft. With 1980 ft of water cushion, the tool was open 83 minutes and closed 95 minutes. After a good blow, water surfaced in 22 minutes, gas in 27 minutes, and oil in 40 minutes. Gas was estimated at 4,000,000 cu ft per day and 50-gravity oil at 10 bbl per hour. Initial flowing pressure was 1600 lb; final flowing pressure, 3150 psi. Shut-in bottom hole pressure was 3550 psi. The operator is now coring ahead.

WEST AFRICA

★ An oil exploration license covering a large area of Senegal, has been granted to The British Petroleum Company's French associate, the Societe Francaise des Petroles BP. A new company, Societe des Petroles de Senegal, is to be formed shortly to take over this license and carry out oil exploration in the area. BP Exploration Company will have a 30 per cent holding in the new company and S.F. BP a 20 per cent holding. The remaining 50 per cent participation will be in the hands of French Government organizations.

BOLIVIA

★ First phase in Bolivian Gulf Oil Company's broad exploration of its new concession area began with an airborne magnetometer survey July 15. It is expected that the 3,750,000-acre area will be flown within about three months. Aero Service Corporation is performing the survey for Bolivian Gulf. The concession area is located east of the Andes, north and east of the Camari oil field. Base for the survey will be Santa Cruz, Bolivia. Much of the concession area is unmapped, and its general geology is not well known. Photo-maps of the area resulting from the survey will be made available to the Bolivian government by the oil company.

NEW GUINEA

★ Australasian Petroleum Proprietary Limited has announced in Melbourne that Kuru Well No. 2 has been spudded-in in Papua and has reached a depth of 566 ft. Casing of 18⅝ in. diameter has been cemented at 563 ft. Kuru No. 2 well is near to and a replacement for Kuru No. 1 which has now been sealed with cement after a gas blow-out at 998 ft. Rig erection is proceeding at Barikewa, in the same general area as Kuru, and the hole is expected to spud-in about mid-August.

There's a
JENSEN JACK
for Every Location

Whether you're lifting oil from the bottom of the ocean or from the top of a mountain, there's a JENSEN JACK engineered to make tough jobs mighty easy . . . and profitable!

36 years of field operations, under all conditions, prove JENSEN'S ability to lift MORE oil for LESS money. Write the JENSEN Folks or see your nearest dealer.

JENSEN JACKS

JENSEN BROS. MFG. CO., INC.
Coffeyville, Kansas, U.S.A.
Export Office: 25 Broad St., New York City

SECONDARY RECOVERY
CABLE ENGINEERING
TECHNICAL CONSULTING
PRODUCTION ENGINEERING
SERVICE, INCLUDING
CORE ANALYSIS

DON'T
GET OUT ON A LIMB

PRESSURE MAINTENANCE WITH GAS OR WATER
REPRESSURING WITH GAS OR WATER

Secure a reliable estimate of cost and of recoverable oil before investing in secondary recovery. Our services include such estimates, as well as complete management of water flooding and gas repressuring projects.

SURVEYS
ESTIMATES
DESIGN
INSTALLATION
SUPERVISION

PETROLEUM ENGINEERS
CABLE ENGINEERING
WICHITA FALLS, TEXAS

ARMITE
DRILL COLLAR
& TOOL JOINT
COMPOUND

NON-ABRASIVE
ANTI-GALLING
LUBES & SEALS
PREVENTS WEAR
JOINTS BREAK EASY
LESS TONG BREAKAGE
NON-CORROSIVE

LED-PLATE ANTI-SEIZE COMPOUND
For Xmas Trees, Valves, Casing, Piping, etc.

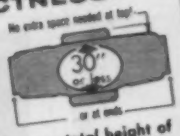
ANTI-SEIZE SEAL
NON-DRYING
70% METALLIC LEAD
PREVENT LEAKS
FOR HI PRESSURE
HI TEMPERATURES

At Supply Stores or Nearest Agent
ARMITE LABORATORIES
6609 Broad St., Los Angeles 1, Calif.

GREATER COMPACTNESS!

Because of the side-opening doors, no extra space need be allowed above the gate—or at the ends—for servicing rams. Even in sizes as large as 13⅝" (12" Series 900) Shaffer Hydraulic Double Gates have a total height of only 30". No extra space above or at the ends is necessary!

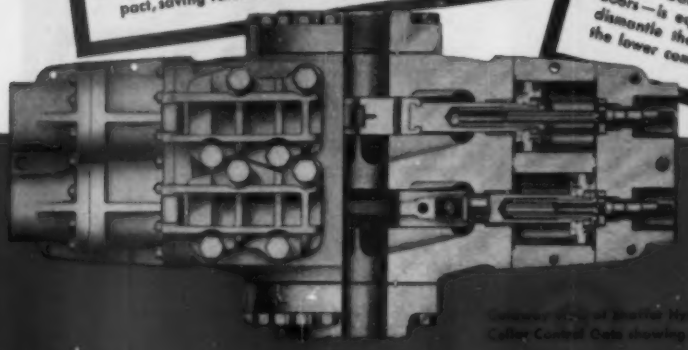
Width and length dimensions are also unusually compact, saving valuable cellar space in all three dimensions.



GREATER ACCESSIBILITY!

Shaffer's patented side-opening doors provide unmatched simplicity in servicing rams. Simply unbolt and open the doors—change rams—and bolt the doors shut again. Closing the doors automatically aligns the rams within the gate.

And in Shaffer Hydraulic Double Gates, each compartment has its own set of doors—is equally easy to service. There's no need to dismantle the upper compartment to change rams in the lower compartment—or vice versa.

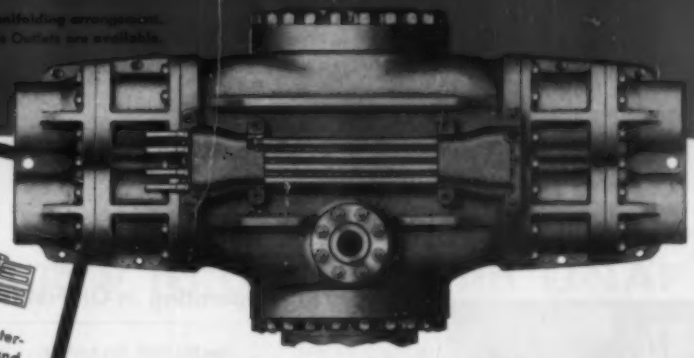


Customer's Cut of Shaffer Hydraulic Double Cellar Control Gate showing simple design.

BUYING HYDRAULIC CELLAR CONTROL GATES?

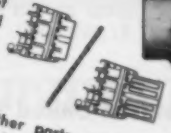
Check these Shaffer advantages against the field!

Rear View of above Gate showing manifolding arrangement. Both Single and Double Outlets are available.



GREATER CHOICE!

Shaffer provides a choice of Single or Double Gates...and a choice of Rising or Non-Rising Locking Shafts. Choose the type and Locking Shaft design that best meets your particular requirements. Rams and most other parts are interchangeable, size for size, for minimum inventory and maintenance costs!



GREATER EFFICIENCY!

Only Shaffer provides Self-Draining Compartment Bottoms with rams traveling on high guide ribs where no detrimental sand or mud can accumulate. Also, Direct Hydraulic Drive (no yokes or complicated secondary connections between rams and hydraulic pistons)... Completely Enclosed Design (no exposed moving parts to become damaged or corroded)...and many other advantages make Shaffer Hydraulic Gates the most dependable, most trouble-free available.

SHAFFER ... pioneers of cellar control gates—not only brings you equipment backed by more than three decades of experience and field-proven dependability, but also gives you *important advantages* found in no other pressure control equipment. Compare them, feature by feature, with other units.

GET ALL THE FACTS on Shaffer's many advantages from your nearest Shaffer representative. Or write direct!

Ask for Shaffer's complete catalog!

Consult the Shaffer Section of your Composite Catalog!

33 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6201 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U. S. A.

What's doing in DRILLING

★ **Larger gasser** has been completed in Texas County, Oklahoma, than the record well reported in this column a couple of months ago. Panhandle Eastern Pipeline is operator drilling the large-volume gassers. The most recent completion is the company's No. 2 Fletcher, northwest of Hardesty on the east side of the Guymon-Hugoton area. With perforations in the Morrow sand zone at 6175-92, the well tested a calculated open flow of 234,913,000 cu ft of gas a day, to become the largest gasser in the three-state area. Early in May the company's No. 2 Allendar tested 172,722,000 cu ft of gas a day on open flow calculation from the same zone.

★ **Pembina field,** Alberta, just seems to grow and grow . . . and grow. One of the several companies operating in the field, Canadian Bishop Oil, Ltd., has just completed drilling up its sixth Crown lease. Completion of this 640-acre parcel brings to a total of 23 the company's producing wells in this field. The last completion, the seventh well on the last lease block, Pembina 2-3, produced 257 bbl per day through a 16/64-in. choke. Tubing pressure was 225 psi, and casing pressure zero. Total depth was 5490. Pembina oil is 37 deg API gravity.

SULTAN OF ZANZIBAR, His Highness Seyyid Sir Khalifa Bin Harub is taking an active interest in deep test well examining oil possibilities on this part of the African Coast. With the sultan is M. M. Pennell, director of BP-Shell Development Company.

★ **Drilling contractors** have had enough of the steel strike to see many of their rigs stacked. Three factors teamed up in July to bring the mid-month active rig count down 28 below last year's total — and 204 rigs not working now that were busy in mid-June. Part of the slump is seasonal; some of the rigs in South Lousiana were hit by permit holdups; many small contractors claimed no casing was available for contracts already "on the books."

★ **Operating agreement** between Voss Oil Company of Newcastle, Wyoming, and Marvel Petroleum Company of Billings, Montana, to drill wells on 30 separate tracts consisting of 25,000 acres of leased land in Wyoming. Voss oil will drill two wells to the Madison formation this year, and has the option to drill a new well at intervals of every 90 days thereafter. Voss will carry wells to the oil sand, then completion costs will be shared equally by the two firms.

★ **Drilling programs** set up for the rest of this year indicate that a record number of wells will be put down by contract drillers to top the 57,000 drilled in 1955.

MAKE IT EASY to follow safety rules on a drilling rig. Paint three safety hats a bright yellow. Display them prominently in a special case at the foot of the steps to the derrick floor — then prepare to raise cain if a visitor pops up on the floor without a safety hat. This is what one contractor did. Only he says that visitors invariably don one of the hats before climbing the steps.

★ **One hundred wells** are being put down by the Ohio Fuel Gas Company this year in Ohio—considerably more than first estimated, and doubling the number drilled by the company last year. Ohio Fuel will drill 70 natural gas storage wells and 30 production wells and rework an additional 55 before the year ends. Cost of the complete project for 1956 is estimated at $1,890,000.

Rotary Rigs Operating in Oil Fields of United States and Canada*

	June 25	July 2	July 9	July 16
Alabama	7	6	6	7
Arkansas	20	16	17	20
Arizona	2	4	4	4
California	120	121	126	124
Colorado	62	66	62	61
Florida	0	0	0	0
Georgia	0	0	0	0
Illinois	92	99	102	82
Indiana	7	7	10	9
Iowa	0	0	0	0
Kansas	178	169	164	145
Kentucky	10	15	15	11
North Louisiana	73	66	70	76
South Louisiana	375	379	382	389
Total Louisiana	448	445	452	465
Maryland	0	0	0	0
Michigan	11	11	10	10
Missouri	1	1	1	1
Montana	46	46	49	51
Mississippi	23	23	23	23
Nebraska	29	32	31	33
Nevada	0	0	0	0

	June 25	July 2	July 9	July 16
New Mexico	152	152	149	137
New York	2	2	2	1
North Carolina	0	0	0	0
North Dakota	18	23	25	27
Ohio	1	1	1	1
Oklahoma	307	297	282	271
Oregon	0	0	0	0
Pennsylvania	6	3	3	5
South Dakota	2	2	2	0
Tennessee	0	0	0	0
Texas Gulf Coast	272	259	251	257
West Texas	393	384	369	361
North Texas	373	360	349	340
East Texas	53	53	58	58
Total Texas	1091	1056	1027	1016
Utah	21	22	23	24
Washington	1	1	1	1
West Virginia	1	2	2	2
Wyoming	84	86	83	84
United States	2742	2708	2672	2615
Western Canada	252	235	236	243
Grand Total	2994	2943	2908	2858

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

CEMENTING DATA
John W. Mecom Well LL & E #1,
Lake Washington Area,
Plaquemines Parish, South Louisiana:
1. 7" casing bottomed at 14,957' was cemented with 500 sacks of neat Unaflo cement.
2. First 100 sacks, of a 200-sack batch of neat Unaflo, was circulated into position behind 5" liner at 16,257'; packer was set and the second 100 sacks squeezed into formation under 4,000 psi. Static bottom-hole temperature 272°F. Mud 15½ lbs. per gal.; funnel viscosity 75 seconds. Hydrostatic mud pressure approximately 13,000 psi.
3. Liner was then squeezed thru perforations 15,650'-15,652' with 100 sacks of neat Unaflo; 95 sacks out in formation under maximum pump pressure of 4400 psi.
4. Liner was squeezed again thru perforations 15,250'-15,252' using 100 sacks neat Unaflo; 10 sacks out in formation under a final pump pressure of 5500 psi. Excess cement reversed out of well. All jobs were successful.

John W. Mecom Well LL & E #1, Lake Washington Area, Plaquemines Parish, So. Louisiana

Cementing below 16,000 ft. with UNAFLO*

DESPITE HIGH TEMPERATURE and pressure Unaflo cement went into place without a hitch on a liner job below 16,000′ and on three other cementing jobs in this well in South Louisiana.

To get this same reliable performance on your next well with critical temperatures and pressures, specify Unaflo Oil-Well Cement. Because Unaflo gives you both high initial fluidity and sustained fluidity, it pumps easily and stays pumpable, yet hardens to form strong, durably bonded cement that is sulphate-resistant.

Unaflo complies with API STD 10A Specifications for oil-well cement, regular type classes D and E. Write for typical data tables on Unaflo's down-the-well performance, and facts on our other cements.

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL (USS) CORPORATION SUBSIDIARY

100 PARK AVENUE, NEW YORK 17, N. Y.

*"UNAFLO" is the registered trade-mark of the retarded oil-well cement manufactured by Universal Atlas Cement Company.

PERFORMANCE-PROVED

U-143

Unaflo

RETARDED OIL-WELL CEMENT

OFFICES: *Albany • Birmingham • Boston • Chicago • Dayton • Kansas City • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • St. Louis • Waco*

United States Steel Hour—Televised on alternate Wednesdays—See your local newspaper for time and station.

TWO DIESEL-ELECTRIC SUBMERSIBLE DRILLING BARGES were christened at the same time recently by Penrod Drilling Company of Shreveport, Louisiana, at the Levingston Shipyards at Orange, Texas. The "W. H. 'Bill' Dordan" (Rig 46) and the "Tom Sorrel" (Rig 47) are slotted barges measuring 105 ft long, 50 ft wide and 12 ft deep. Bulk of the drilling equipment was furnished by Continental Supply Company, and each rig is powered by three diesel electric power units from General Motor's Electromotive Division. Rig 46 went into operation south of Morgan City, Louisiana, and Rig 47, nearly complete, will go to work soon.

★ **Twenty more rigs** will be purchased by Pemex this year for use in Mexico, Antonio J. Bermudez, managing director of Petroleos Mexicanos, revealed in Houston recently. Speaking before a luncheon given by Reed Roller Bit, Bermudez disclosed that the company has discovered 17 new oil and gas fields and has completed over 180 wells thus far in 1956. Pemex has already ordered 20 rigs to be delivered this year, bringing the total of drilling and servicing rigs to 110, 34 of which are workover rigs. When the rigs to be ordered in the last quarter of this year are placed in service, Pemex will have a total of 130 rigs operating.

★ **Sixteenth annual meeting** of the American Association of Oilwell Drilling Contractors, October 7-9, is expected to be a record meeting, based on returns from members' reservation forms pouring in. This year's meeting will be at the Texas Hotel, Fort Worth, Texas. Members have been urged to return housing reservations at the earliest possible date.

★ **Soviet oil rig sales** to India now total $2,800,000 for three complete units purchased in June. India is also readying a fourth rig for operation, coming from Communist Romania.

★ **Larger drilling platform** than the "Scorpion" has been ordered by Zapata Offshore Company. The new $3,250,000 unit is already under construction by R. G. LeTourneau and will be on the general order of Zapata's first tripod-type unit commissioned in April. The new 8,000,000 lb unit is scheduled for completion by February, 1957. Deck of the platform will be 194 ft long and 152 ft wide. Operators say several new improvements are being incorporated in the new unit, not existing on the "Scorpion."

★ **Farm-out deal** has been taken by Texota Oil Company from Stanolind Oil & Gas to drill 10 gas exploration tests in Sedgwich County, northeastern Colorado. Wells will be on a trend between the Big Springs gas field of Deuel County, Nebraska, and the Haxtun gas field of Phillips County, Colorado.

★ **California offshore drilling** is being planned by several companies along the Point Conception to Newport. A converted Navy barge is being equipped at Los Angeles for a core hole exploratory program extending about 200 miles down the coast. Shell Oil, Union Oil of California, Conoco, and Superior Oil are partners in the joint venture.

★ **"15 Years of Drilling Progress"** has been reviewed in a new booklet recently published by the American Association of Oilwell Drilling Contractors. A status report of the billion-dollar drilling industry, the 36-page book recounts how the aims have been furthered, primarily through the work of AAODC committees studying engineering problems, safety in drilling operations, management topics, and employee relations. Highlighted in the manual are the association's education and training activities. According to the publication, AAODC training courses have been attended by more than 25,000 men, amassing 300,000 student hours. Printed for private distribution to members, the booklet is being placed in the libraries of petroleum engineering schools and oil industry associations.

★ **Merger** of two Midland, Texas, drilling companies has been completed. Pete Lomax Drilling Company and Brantly Drilling Company are the two principals. The new organization will be known as Brantly Drilling Company, Inc., and will operate eight rotary rigs in the Permian Basin of West Texas and New Mexico. Four rigs came from each of the two firms. M. M. Brantly, president of Brantly Drilling, will continue in that capacity. Pete Lomax, president of Lomax Drilling, will continue active in the industry as an independent oil operator. Murphy Baxter, a partner in the Pete Lomax Drilling Company, is now secretary-treasurer of the new Brantly Drilling Company.

★ **Rocky Mountain drillers** are meeting in executive conferences in Denver, Colorado, and Casper, Wyoming, to discuss views on economic and management aspects of the industry. First meeting was in Casper late in July. The Denver conference is slated for August 8-10. Among other subjects discussed in the AAODC sponsored sessions are channels of communication as related to realistic bidding practices. Conference programs are being arranged by the Petroleum Extension Service of the University of Texas.

★ **Four well exploration program of** Oil Selections, Ltd., in Quebec indicates that evidence of oil and gas have been found. The company is drilling tests in L'Assomption County, a few miles northwest of the St. Lawrence River. The wells are being drilled in a straight line about one mile apart, with drilling to the limestone. Ranch Drilling Company has been contracted to do some of this work.

ANNOUNCING the new SUPER GIANT RIG...

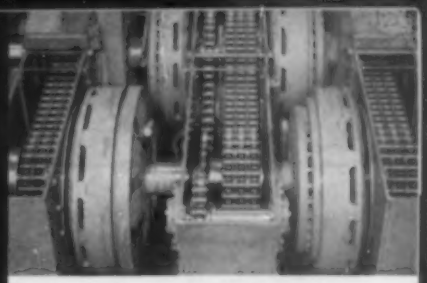
unquestionably...the most advanced and modern rig in the world today

YOU OWE IT TO YOURSELF TO INVESTIGATE THIS NEW AND MODERN RIG BEFORE BUYING

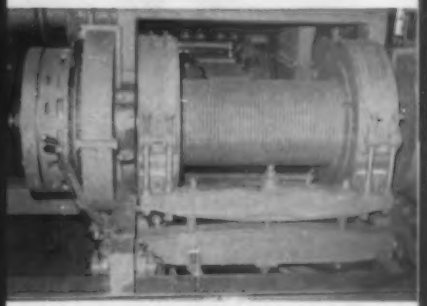
Write for Full Details

WILSON MANUFACTURING CO., INC.

WICHITA FALLS, TEXAS • the home of RED IRON



- *With New Three Speed and Reverse All Friction Clutch Transmission*
- Available with Parkersburg 22" Single Hydromatic Brake Mounted on Transmission *with 6 Speeds Between Drum and Brake* — The Best Hydromatic Brake Arrangement Yet Devised!



- With New Beam Equalizer, Single Nut Adjustment Lever Type Brake which CANNOT KICK.
- Oil Bath Drum Drive Chains Outside Frame
- High and Low Clutches on End of Drum Shaft
- Heavy Plate Chain Cases and Covers

be modern-

buy Wilson

RUNNING TOUR with MEN in the INDUSTRY

Kingsley V. (King) Schroeder . . . named director of production for Sun Oil Company in the United States and Canada. He succeeds **Robert W. Pack**, who is retiring.

Schroeder, with Sun since 1933, was assistant division manager of the Gulf Coast production division, where he is succeeded by **L. Millard Moor**, who has been administrative assistant to division manager.

K. V. Schroeder

L. M. Moor

E. D. Loughney . . . formerly vice-president of Canadian Gulf Oil Company, elected a director and appointed vice-president of British American Oil, with headquarters in Toronto. A veteran of 28 years with the Gulf Companies, Loughney has been general manager of Canadian Gulf since 1951, and vice-president since 1954.

O. I. Torkelsen . . . appointed vice-president and general manager of the company's exploration, production and pipe line operations in Western Canada. He has been associated with B-A's exploration and production department since 1939, and since 1953 has been vice-president in charge of B-A's exploration and production in Western Canada.

Richard C. Marmaduke . . . appointed chief geologist for The British-American Oil Producing Company, transferring from the central division where he had been division geologist. With British-American since 1952, he is succeeded by **Harold J. Reedy.**

Donald L. Kastner . . . appointed assistant division production superintendent at Odessa, Texas, by Cities Service Oil Company. He joined the company's engineer training school in 1947 and served as district engineer and district superintendent.

William H. Flood Jr. . . . appointed to the newly created position of production manager for Northern Natural Gas Producing Company. A 20 year veteran in the petroleum industry, Flood comes to Northern after 12 years with Republic Natural Gas Company as district superintendent at Republic's Guymon-Hugoton district at Hugoton, Kansas.

W. H. Flood, Jr.

R. B. Gaines . . . geological engineer joined the gas reserves and availability section of the gas supply department of Northern. Formerly he served as geologist for Southern California Petroleum Corporation.

E. A. Roberts Jr., production manager; **George I. McFerron**, chief geologist, and **Dr. William A. Gorman**, exploration geologist . . . promoted to vice presidents by Drilling and Exploration Company, Inc., with headquarters in the Houston offices.

Roberts joined Drilexco in 1945 as district engineer. McFerron has been Drilexco chief geologist for the last four years, and previously was division geologist for Sohio Petroleum Company and a member of the firm of Wiggins & McFerron Oil Company. Gorman, with Drilexco two years, was vice-president of Rycade Oil Corporation and prior to that manager of Royal Oil & Gas Corporation.

Earl A. Nichols . . . appointed consulting engineer for newly-organized Stekoll Properties, to supervise the analysis of oil and gas leases offered to the company. Nichols was previously with Core Laboratories as assistant to the president and manager of the Mid-Continent division of all operations.

Allyn R. Bell Jr. . . . controller, General Crude Oil Company, elected a vice president of the Controllers Institute of America. A member of the institute since 1944, Bell was president of the Institute's Houston Control in 1953-54, and was elected a national director in 1954.

Gordon E. Jacober . . . appointed exploration manager for Texas Pacific Coal and Oil Company's Rocky Mountain division. With eight years' geological service, he previously was with Sun Oil Company, Husky Oil & Refining Company, and Standard Oil Company of California.

N. E. Thompson

Norman E. Thompson . . . appointed district geologist in charge of Nortex Oil and Gas Corporation's new district office in Corpus Christi, Texas. Prior to joining Nortex, Thompson was district geologist for Lion Oil Company.

L. H. Meltzer . . . geologist, opened offices in New Orleans, Louisiana. Formerly with Union Producing Company as geologist for 19 years, he resigned as head of the exploration section of the geological department.

Charles A. Chipman . . . re-elected to his fourth one-year term as president of the Pennsylvania Grade Crude Oil Association.

Other officers re-elected at an annual meeting of the board of directors include: **George J. Hanks**, president of South Penn Oil Company, first vice president; **A. C. Simmons**, Simmons Oil Company, second vice president; and **Fayette B. Dow**, vice president and general counsel.

Others are **Samuel Messer**, Quaker State Oil Refining Corporation, treasurer; **F. W. Alcorn**, Pennzoil Division, South Penn, **C. L. Suhr**, South Penn, and **C. G. Johnson** of Quaker State, assistant treasurers; and **W. C. Wenzel**, executive manager.

A. R. West

A. R. (Al) West . . . formerly division manager of the Carter Oil Company's southern division in Shreveport, joined Tennessee Gas Transmission Company as production manager.

He had been with Carter since 1937.

Southwest Gas Producing Company, Inc. announced the following changes in personnel: In the general office at Monroe, Louisiana, **Arthur R. Smith** was appointed manager of the land department and **Barney F. Pate** was appointed geologist. At Lafayette, Louisiana, **A. E. Beasley** was appointed manager of the district office and **Joseph F. Moss**, formerly with Sun Oil Company, was named district geologist.

Dr. Guillermo Jose' Salas . . . Cia. Shell de Venezuela, Ltd., received the first degree of petroleum engineering granted by the National University of Zulia. After receiving a degree in civil engineering at the University of Zulia, he was awarded a scholarship to the University of Tulsa by Shell. He is currently doing secondary recovery work at Lagunillas in Western Venezuela.

G. J. Salas

H. J. Gruy . . . opened consulting offices in Dallas, Texas. Previously employed by DeGolyer and MacNoughton, and the Shell Oil Company, Gruy recently had offices as a petroleum consultant in Fort Worth, Texas.

R. Scott Graham . . . petroleum engineer, is now associated with John S. Herold, Inc. He was formerly with Creole Petroleum Corporation and Carter Oil Company as a production and reservoir engineer.

Foster J. Schempf . . . appointed general manager of Louisiana operations by John W. Mecom, Houston independent oil operator. Schempf has been vice president and director of exploration for the Stanolind Oil & Gas Company at Tulsa, Oklahoma.

Augustin Pyre . . . named general manager of Gulf Oil Corporation's New York exploration division succeeding **Claude Woessner**, retired after 29 years' service with the Gulf Oil Companies.

Augustin Pyre

With Gulf since 1937, Pyre was previously with Gulf Eastern in London. Woessner joined Gulf in 1927 and was named general manager of the New York production division in 1951.

Over 60 *Locations in the United States and Canada*

McCullough® REPORTS TO THE OIL INDUSTRY

Service® *Anywhere Anytime*

New Services • • • New Tools • • • New Methods • • • Outstanding Results

McCullough Back-off Service Simplifies Fishing Job

Enables Fastest Possible Recovery of Cemented-in Tubing String

While this wildcat was being completed, a packer and 2⅛" tubing were cemented in the 7" O.D. casing by error. The productive sand which was to be tested lay at 7,660'.

Faced with a tough pipe recovery job, the operator called for McCullough Back-Off Service. The Magna-Tector was run and located the lowest free point at 7,449' and the nearest collar that could be backed off at 7,430'. The entire zone to be tested had been cemented-in.

Next, a McCullough String Shot was run which loosened the collar at 7,430'. Tubing was backed off and removed from the well. The balance of the tubing was washed-over and cut out, permitting the operator to complete his well program in the fastest possible time.

The entire back-off job was completed in only three hours rig time and was done in 25° below zero weather.

Due to the accuracy and reliability of McCullough Back-Off Service, all free tubing was recovered on the first try. Also, the balance of the fishing job was minimized to the point where it could be completed with the least possible expense and loss of rig time to the operator.

Magna-Tector Helps Recover An Extra 3680' of Casing

McCullough Magna-Tector and Jet Casing Cutter Slash Abandonment Costs by Recovering 61% More Casing Than Expected

Substantial savings were realized by this Wyoming operator in the abandonment of an 11,000' well. McCullough's Magna-Tector accurately located the stuck point, indicated that the pipe might be freed to greater depths, then confirmed the progressive loosening of the string as the pipe was worked.

Casing was 7" O.D. 29 lb. N-80. A temperature survey located the top of the cement at 7,550'. The operator was expecting to recover a maximum of 6,000' of casing and called McCullough to exactly locate the lowest free point at which it could be cut.

On the first run of the operation, the Magna-Tector found the casing stuck at 5,000' and cutting the pipe at that depth was considered. However, since the Magna-Tector indicated that the casing might be freed still deeper by working, the operator decided to give it a try.

The pipe was worked for two hours. Periodic checks by the Magna-Tector showed the casing was loosening progressively deeper, until finally the string was free at 9,700'.

A 7" McCullough Jet Casing Cutter was run and the cut made at 9,680'. Total rig time on the job was only six hours.

Guesswork in pipe recovery operations is entirely eliminated by the use of the McCullough Magna-Tector (Free Point Finder). It quickly and accurately locates the lowest free point from which pipe may be recovered. It may also, as in this case, indicate that working the pipe will free it to greater depths.

A bonus of an additional 3,680' of useable 7" N-80 casing was no small saving on this job.

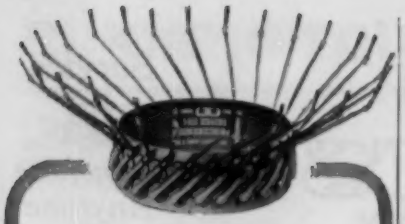
RECOVER ALL FREE PIPE ....

When pipe is stuck, call for the McCullough Magna-Tector (Free Point Finder). Locates lowest free point, accurately and in a hurry. Paves the way for fast recovery of all free pipe and speeds up remaining fishing operations. You save money, rig time and recover more pipe.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

LOS ANGELES
HOUSTON
EDMONTON



for a good cement job...

B and W

SCRATCHERS and CENTRALIZERS

Removal of mud cake and prevention of channeling are required for good primary cementing.

B and W introduced the first scratchers to the oil industry in 1939 . . . and in 1946, the first latch-on centralizer, with the Kon-Kave bow for extra centering strength.

These tools, part of B and W's complete line of primary cementing tools, help assure proper hole conditioning for a good cement job.

- B and W Multi-Flex Scratcher
- B and W Hinged Nu-Coil Scratcher
- B and W Rotating Scratcher, Multi-Flex type
- B and W Rotating Scratcher, Nu-Coil type
- B and W Latch-On Centralizer with Kon-Kave Bow
- B and W Latch-On Stabilizer
- B and W Stabilock

B and W Inc.

Well Completion Specialists

GULF COAST
Box 5266
Houston 12, Texas
Phone WA 3-6603

WEST COAST
Box 3751, Terminal Annex
Los Angeles 54, Calif.
Phone DA 4-1106

6000

Running Tour

▸ The Southwestern producing division of The Pure Oil Company announced these personnel changes: **John J. Collier Jr.** . . . new assistant to the division manager in exploration, in addition to his present duties as division exploration manager.

Charles W. Hancock . . . promoted to assistant to the division manager in producing from assistant division production superintendent. **Charles L. Schneider** . . . named assistant division production superintendent succeeding Hancock.

John R. Weyler . . . promoted to assistant chief division production engineer from senior engineer. **Jerry J. Wasicek** . . . named senior production engineer in the Tulsa office engineering department.

▸ **Herman Kaveler** . . . consolidated offices in Tulsa, Oklahoma, with Alex McCoy and Associates in consulting geology and geological engineering. **R. Gordon Humphries** is resident manager and engineer, and branch offices are in Casper, Wyoming and Denver, Colorado, in addition to Calgary, Canada, and Tulsa.

▸ **Joe W. Hancock** . . . named superintendent of drilling for Natural Gas Pipeline Company of America, succeeding superintendent Charles I. Galloup, who retired.

Hancock has completed 20 years with the company and prior to his promotion was assistant superintendent.

▸ **W. L. Kitsman** . . . promoted to the position of district superintendent of Phillips Petroleum Company's Canadian production operations. He replaces **W. S. Derrick** . . . transferred to the Bartlesville, Oklahoma, headquarters. Previously Kitsman was assistant division superintendent of the company's western division, Midland, Texas.

▸ **Cliff W. Peery** . . . elected vice president of the Mene Grande Oil Company. With Mene Grande 22 years, Perry rose to general superintendent in 1949 and was Caracas operations manager last year.

▸ **Malcolm Abel** . . . resigned as division manager of BBM Drilling Company to become general manager for W. E. Bakke Oil Company. Abel was formerly with Plymouth Oil Company as division engineer before joining BBM.

▸ **Charlie Bryce** . . . appointed drilling superintendent of B. L. McFarland, Inc. and assistant to the president. With 20 years experience in the drilling business, Bryce formerly served as vice president of Delaware Drillers.

▸ **Lloyd K. Strange** . . . promoted to senior research technologist for Magnolia Petroleum Company. He had been a member of the technical staff of the company's field research laboratories.

▸ **Michael S. Reford** . . . appointed as geophysicist for Canadian Aero Service Limited. He was formerly with Mobil Oil of Canada, Ltd., as geophysicist in charge of Mobil's Western Saskatchewan district.

▸ **W. C. Summy** . . . transferred to Sinclair Oil & Refining Company in Venezuela as superintendent of its Santa Barbara operations. With Sinclair for over 29 years, he was formerly assistant division production superintendent for Sinclair at Houston, Texas.

▸ **R. E. Wright** . . . appointed staff petroleum engineer for the domestic producing department of The Texas Company. With The Texas Company since 1946, he was in the general manager's office a year.

▸ **John H. Crump** . . . elected vice president of United Producing Company to have charge of the firm's oil and gas operations in the Gulf Coast area. Associated with the oil and gas industry since 1929, Crump was most recently a director of Commonwealth Gas Corporation, and vice president of Monla Gas.

John L. Crump

▸ **Grier Zimmerman** . . . tool pusher and drilling engineer, Kerr-McGee Oil Industries, Inc., fills newly-created position of supervisor of drilling operations.

W. C. (Carl) Lawson . . . tool pusher on Kermac's Rig 44, named central Gulf division drilling superintendent, and **Kenneth W. Parker** . . . for five years a tool pusher and drilling engineer in the Gulf Coast region, transferred to Oklahoma City as special assistant to general manager of drilling and production operations.

▸ **Art Hazle** . . . heads newly-formed, independent oil company, Paramount Petroleum & Mineral Corporation, Ltd. of Regina, Canada. **Thomas L. Jermyn** . . . is vice president and **Mrs. I. Hoffman** . . . secretary-treasurer.

Hazle was with Trans-Western Drilling Company, Bennett-Burns Engineering & Equipment, Ltd., and was development and sales engineer for Petroleum Industry Services, Ltd.

▸ **Marshall C. Turner** . . . appointed manager of Monterey Oil Company's newly created California division, located in Long Beach. In the industry since 1937, Turner was previously assistant to the chief production engineer with Phillips Petroleum Company.

▸ **W. M. Jones** . . . transferred to Stanolind Oil and Gas Company's Drayton Valley office, as field superintendent. He has been field superintendent in Henderson, Texas, since 1952.

Seagoing OIL RIG

For complete information, write:
The INGALLS Shipbuilding Corporation
Birmingham, Alabama

WHAT USERS SAY
about Bucyrus-Erie Spudders

MICHIGAN, OPERATOR, 28-L: "Nicest rig I ever worked on . . . Bucyrus spudders really cut the hole and stand up well. They're easy to handle, too."

KANSAS, OPERATOR, 36-L: "Runs just fine . . . sure like those brake blocks. The 3-drum unit makes it simple to switch from baling, drilling, or running tube and rods. I also like the smooth running belt drive in place of noisy chain drive of competitive rigs."

ONTARIO, CANADA, CONTRACTOR, 60-L: "I like the 60-L's sturdy construction and easy operation. It's tops for this kind of drilling in sand and gravel surface where casing must be driven down almost 300 feet. It's easy to move, too."

OKLAHOMA, OWNER, 28-L: "We're very much pleased. This is the 26th well in 10 months continuous drilling, and the only repair expense has been $33 for two bearings."

WYOMING, OWNER, 36-L: "This rig has been in steady operation — drilling, cleaning-out, and tailing-in — for 5 years and has never been in the shop."

ILLINOIS, OWNER, 60-L: "In a more and more competitive business you can't make money and build a reputation with junk equipment . . . people get the wrong impression. The finest kind of modern machinery is the soundest investment a man can make."

PENNSYLVANIA, OWNER, 60-L: "Past record of our 28-L sold us on the 60-L before we even used it."

COLORADO, OWNER, 48-L: "Last word in drilling with cable tools."

These are actual quotes from users* of Bucyrus-Erie spudders on various drilling contracts throughout the country. In state after state, these experienced oil well contractors and operators say basically this: "We recognize the value of Bucyrus-Erie's close attention — during manufacture — to all the things that assure outstanding quality. The resultant fine performance, long-life construction, easy operation, mobility, and dependability of these spudders are the things that put the extra profits in our contracts."

Consider these quotes carefully. Then see your nearby distributor for the complete story on Bucyrus-Erie spudders. There's a size to fit your drilling needs.

*Names on request

31556

60-L 1,500-ft., top-to-bottom; 2,000-ft., servicing

28-L 2,500-ft., top-to-bottom; 3,000-ft., servicing

36-L 3,500-ft., top-to-bottom; 4,000-ft., servicing

48-L 6,000-ft., top-to-bottom; 7,000-ft., servicing

BUCYRUS ERIE

South Milwaukee, Wisconsin

FIRST with the FINEST in Spudders

On July 10, 1956 . . . The one millionth operation by Schlumberger was run on the Humble Oil and Refining Company's Danbury Gas Unit No. 6, Well No. 1 in the Danbury Field.

When Schlumberger introduced electrical well logging to oil operators in the United States in 1929, it was a radically new approach to oil exploration. It was almost unbelieveable that accurate information could be obtained in such a manner; but it could — and was — time after time.

The years between the first and the millionth operation in the United States have seen the Schlumberger organization expand to supply the needed service to a growing oil industry.

Time after time, an aggressive Schlumberger research program has provided the oil man with new services for better well evaluation and completion.

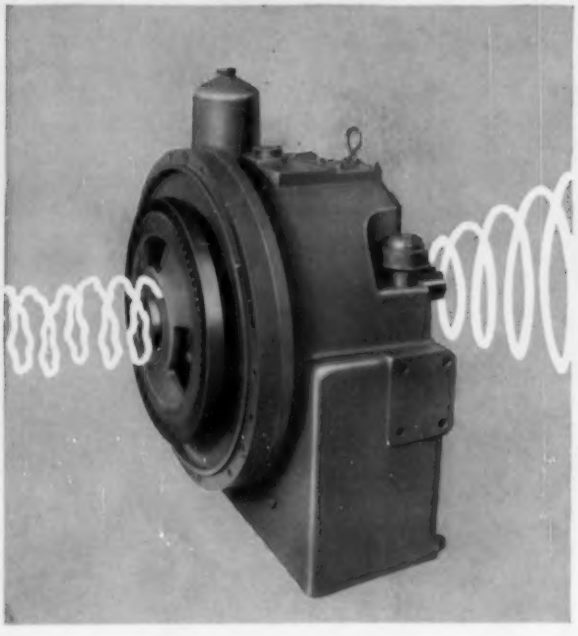
This experience earned in making a million operations is yours today when the familiar blue and white truck rolls up to your well. And the determination to pioneer — to improve — to excell — still dominates the Schlumberger organization just as it did one million operations ago.

SCHLUMBERGER
WELL SURVEYING CORPORATION

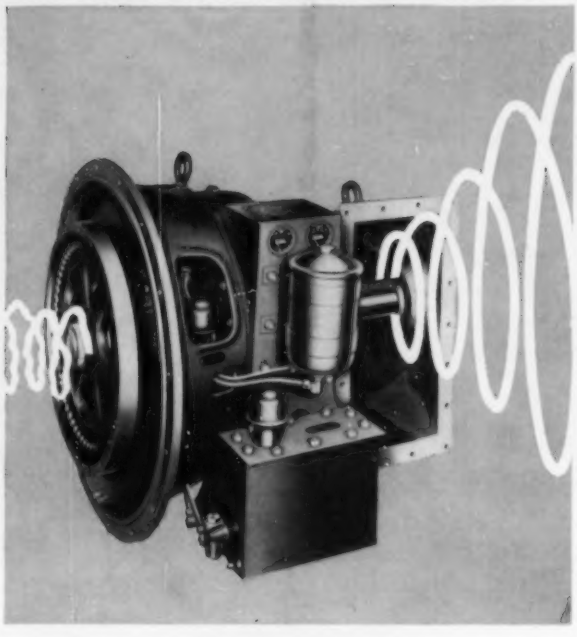
THE EYES OF THE OIL INDUSTRY

IT HAS BEEN DONE A MILLION TIMES

Single-Stage or Three-Stage Torque Converters?



Single-Stage Torque Converter



Three-Stage Torque Converter

The answer to this question depends largely upon the characteristics of the equipment you manufacture *or* use and the jobs it is required to do. Naturally, many factors must be known before any engineering department can be expected to make recommendations.

Generally speaking, however, when it is desired to have minimum pulldown from governed engine speed—with maximum power output over a wide range—and to produce high torque ratios for hoisting or heavily loaded vehicles, a three-stage torque converter, with torque multiplication up to *six times*, may be most desirable. On the other hand, where mild torque conversion is required, as in certain types of vehicles and in other industrial equipment — a single-stage converter may be the best choice.

Now, for the first time, you can benefit from the *unbiased recommendations* of one manufacturer in choosing a torque converter—*single-stage or three-stage* — with the exact capacity and torque transmission characteristics to give your equipment *maximum efficiency.*

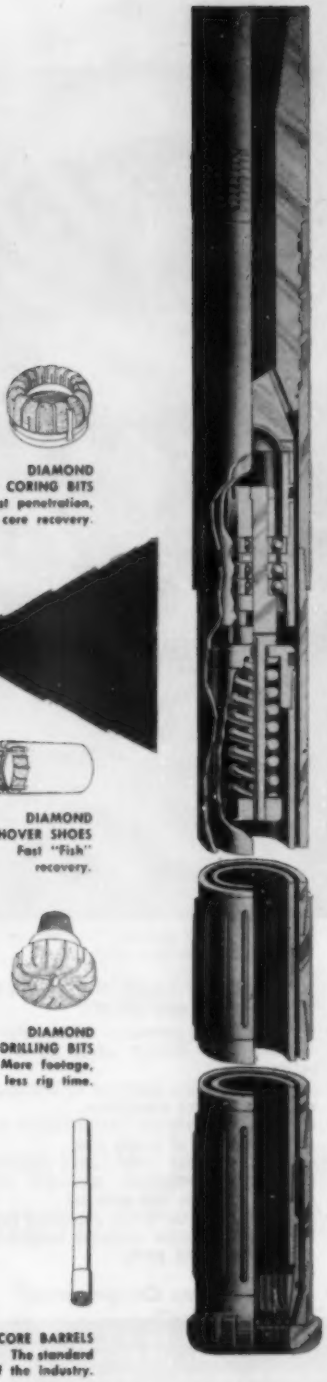
The Twin Disc Clutch Company's new line of single-stage torque converters—now available in the 1500 Series—complements its time-tested, universally accepted line of three-stage units. Single-stage *or* three-stage—from 30 to 1000 hp—you can depend on Twin Disc Torque Converters to give your equipment better performance . . . less downtime . . . and greater earning potential.

In addition to offering *the most complete — the most versatile* line of industrial torque converters available, Twin Disc manufactures fluid couplings in a wide range of sizes for engines and motors from ¾ to 850 hp, and friction clutches for applications from fractional to 1050 hp.

For *smooth, dependable* transmission of power to *your* oil field equipment, *standardize* on Twin Disc—the world's largest manufacturer of fluid and friction drives for powered industrial equipment. For complete details, call the Twin Disc District Office nearest you: Tulsa, GIbson 7-1578; Dallas, RIverside 3014; Los Angeles, LOgan 8-3309.

TWIN DISC CLUTCH COMPANY
Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

D & S core barrels get the job done . . . faster, better, more economically



DIAMOND CORING BITS
Fast penetration, full core recovery.

DIAMOND WASHOVER SHOES
Fast "Fish" recovery.

DIAMOND DRILLING BITS
More footage, less rig time.

CORE BARRELS
The standard of the industry.

Drilling & Service has long been the industry's leader in the manufacture of quality core barrels. Field-proved and tested, D&S core barrels meet and surpass all oilfield requirements. Years of research and experience are built into each. Check these D&S advantages: Longer core runs are possible and fishing jobs are simplified. Faster penetration in soft or hard formations mean *more* overall rig savings! Specially rolled tubing is an added safety factor. Full circulation, elimination of core washing, and less core friction and wedging are assured. D&S core barrels give you connection every time and core recoveries not affected by formation changes.

Write or call today! One of our sales engineers will call on you and explain our custom-services and equipment. Herein lie the real D&S advantages.

TRUCO DIAMOND BITS

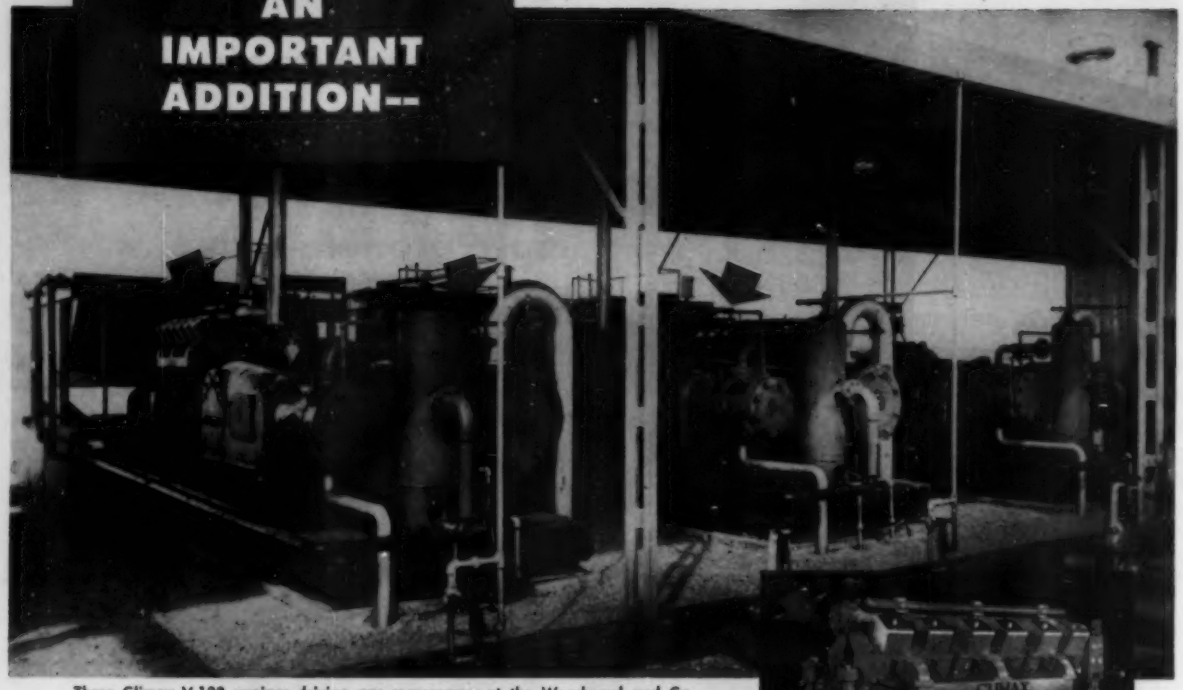
Drilling & Service INC. | **DIAMOND DRILLING EQUIPMENT**

6210 NORTH CENTRAL EXPRESSWAY | DALLAS, TEXAS

OFFICES IN ALL PRINCIPAL OIL AREAS

Ultra Fine Diamond Equipment for the Oilfield

AN IMPORTANT ADDITION--



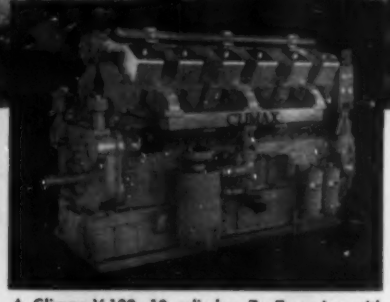
Three Climax V-122 engines driving gas compressors at the Woodward and Co. Gasoline Plant near East Washington, Okla.

TO A *GROWING LIST* OF CLIMAX ENGINE INSTALLATIONS

Climax heavy duty gas engines were selected to drive the compressors in Woodward and Company's new gasoline plant near East Washington, Oklahoma. This plant, having a design capacity of 3.5 million cubic feet per day, was engineered and constructed by Tinkham Engineering & Construction Company of Dallas, Texas, and includes three Model V-122 Climax engines driving Oil Well Supply DGE-250 gas compressors.

Rugged construction, modern design and a reputation for long service with maximum economy and minimum down time are features which make Climax engines outstanding wherever dependable power is required.

Climax engines are specially designed for compressor drive and are available in sizes from 100 to 350 H.P. for 24-hour round-the-clock service.



A Climax V-122, 12 cylinder, 7 x 7 engine with a 3232 cubic inch displacement.

OUTSTANDING FEATURES OF CLIMAX V & K SERIES ENGINES

- All models have renewable cylinder sleeves.
- All intake and exhaust valves are free-to-rotate type.
- All crankshafts are supported by bearings on each side of each crankthrow.
- All connecting rods are rifle drilled for pressure lubrication of piston pins.
- All cylinder heads have Climax high-turbulence type combustion chambers which produce maximum fuel economy.
- All models have the Climax consistent design that makes possible maximum interchangeability of wearing parts.

Write today for your copy of bulletin SA-611, "Special Power Units for Gas Compressors."

WHERE POWER IS YOUR PROBLEM — CLIMAX IS YOUR ANSWER

climax BLUE STREAK ENGINES

DISTRIBUTORS
Sales and Service

Drillers Machine Shop, Oklahoma City, Okla.
•
General Diesel and Equipment Company (Formerly Sweeney Bros.) Williston, North Dakota)
•
Wilson's Engine & Equipment Co. Bakersfield & Long Beach, Calif.
•
Stewart & Stevenson Services, Inc. Houston and 8 Texas Branches
•
Cullander Machinery Co. Belzoni, Miss. & West Memphis, Ark.
•
Tobin Machinery Co. Lafayette, La.
•
Vern Walton Co. Coolidge, Casa Grande & Marana, Ariz.
•
Landes, Zachary and Peterson Denver, Colo. and 5 Branches
•
United Power, Inc. (Formerly United Tool Co.) Shreveport & Alexandria, La.

CLIMAX ENGINE AND PUMP MFG. CO.
208 SO. LA SALLE ST. CHICAGO 4, ILL.
FACTORY • CLINTON, IOWA
DISTRICT OFFICE • 155 CONTINENTAL AVE., DALLAS 7, TEXAS

You guess ...we can't!

10 YEARS AGO *THIS FAMILIAR SILHOUETTE ON THE OIL FIELD HORIZON WAS EASILY DISTINGUISHED AS A*

LUFKIN

TODAY...*MUCH CLOSER SCRUTINY IS NECESSARY TO IDENTIFY THE MANUFACTURER OF THIS PUMPING UNIT*

DO NOT BE MISLED BY APPEARANCE

SEE OUR CATALOG IN THE COMPOSITE CATALOG

"Look beneath the surface; let not the several quality of a thing nor its worth escape thee"..... *Marcus Arelius*

Lufkin **FOUNDRY & MACHINE COMPANY**

LUFKIN, TEXAS

Branch sales and service Houston, Dallas, New York, Tulsa, Los Angeles, Seminole, Oklahoma City, Corpus Christi, Odessa, Kilgore, Wichita Falls, Casper, Wyoming, Great Bend, Kansas, Effingham, Illinois, Duncan, Oklahoma, Brookhaven, Mississippi

Lufkin Equipment in CANADA is handled by

THE LUFKIN MACHINE CO., LTD., 14321 108th Avenue, Edmonton, Alberta, Canada.

RECTOR type "M"

..the Tubing Head that's WAY ahead ..in Flexibility

MANDREL HANGERS

Type "A" Mandrel Hanger threaded for EUE or regular tubing.

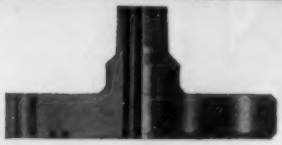
Type "M" Stripper for tubing heads with locking screws.

Type "A-O" Mandrel Hanger threaded, also grooved for locking screws. The "O" Ring serves as temporary seal.

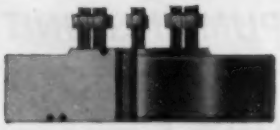
Type "WM" Wrap-Around Mandrel. It is hinged to wrap around tubing; also grooved for locking screws.

Type "C" "Slick Joint" Mandrel grooved for locking screws. The "O" Ring serves as temporary seal.

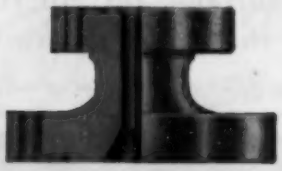
BONNETS



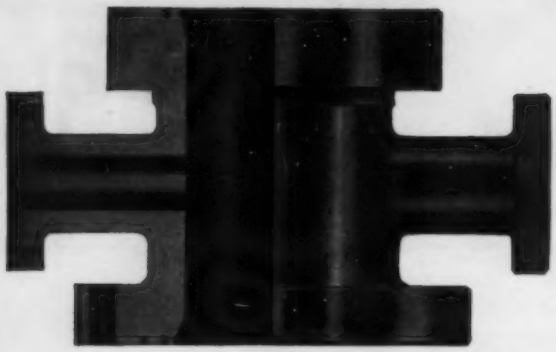
Male threaded bonnet also available with underside female threaded to hang tubing.



Studded bonnet also available with underside female threaded to hang tubing.



Spool-type bonnet also available with underside female threaded to hang tubing.



• The wide range of body types (6), the complete range of pressures (2,000 to 15,000 lb. test), the variety of mandrel hangers and bonnets (10) . . . all of which are interchangeable in the bodies, plus auxiliary equipment, make it possible to select a Rector Type "M" Tubing Head for every well completion condition and preference.

Every one of these heads employs the proven Rector principle of sealing with steel . . . a single API Ring Gasket acting dually as seal and hanger hold-down. There are no soft or resilient seals in these heads to deterioriate, burn out, freeze or contract in extremely low temperatures.

When planning well completions . . . specifying Christmas Trees . . . specify a Rector Type "M" Tubing Head for the utmost in safety and flexibility.

For complete specifications of all Type "M" Tubing Heads, Mandrels and Bonnets, see the Composite Catalog.

RECTOR WELL EQUIPMENT COMPANY INC

MAKING THE OIL INDUSTRY SAFER

1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

REPRESENTATIVES IN ALL ACTIVE FIELDS

RECTORHEAD RECTORSEAL

Drill Deeper with Old Rig!

LEBUS

COUNTERBALANCE

increased rig depth rating!

Yes, you can actually INCREASE the depth rating of your present rig by simply utilizing LEBUS COUNTERBALANCED SPOOLING. For example, look at the illustrations at left. The first sketch shows two engine rig capable of drilling wells to depth of 6,000 ft. The second sketch is of same rig equipped with LEBUS COUNTERBALANCED SPOOLING and one additional engine. Its rated capacity now has been increased to approximately 10,000 ft.

LEBUS COUNTERBALANCED SPOOLING is the only method of spooling line that will control the line properly while being run at top speed!

Get the complete facts — get increased efficiency and cut wire line cost at once.

Get all the facts — contact a LeBus representative or LeBus direct — NOW.

Patent Nos.: Counterbalanced Spooling, Nos. 2,734,695; 2,732,150. Controlled Parallel and Helical Spooling, Nos. 2,708,080; 2,620,996. Appli. of grooving, Nos. 2,599,926; 2,204,938. Removable End Fillers, No. 2,216,819. Other patents pending.

LeBus International Engineers, Ltd.

Executive Offices: 305 Wichita National Bank Building, WICHITA FALLS, TEXAS
Sales, Service Control and Warehouse Stock: LONGVIEW, TEXAS

"LIKE TO GET EVERY FOURTH WELL FREE?"

KEEP UP YOUR PRESENT DRILLING COMMITMENTS WITH LESS INVESTMENT PER WELL. USE A CASING HANGER.

BURNS CASING HANGERS

CASE HISTORY

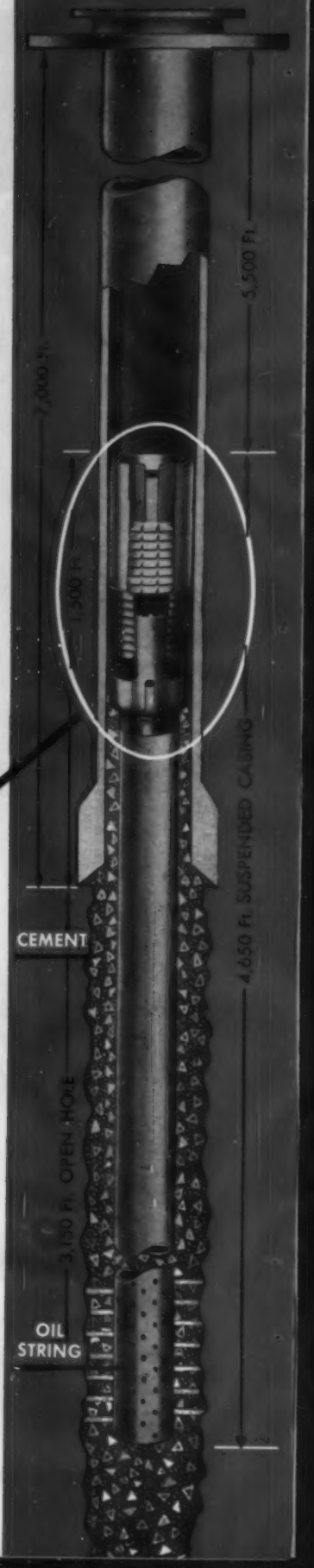
NO. 1875 BUCANA Oil COMPANY

Protective Casing (8⅝") set at 7,000 ft. Oil string (5½") set at 10,150 ft. and hung on Burns Liner Hanger at 5,500 ft. thereby saving the cost of overlapping the 5,500 ft. of 5½" casing. Burns Hanger also eliminates hanging the weight of 5,500 ft. of oil string from the landing head. Cemented for 1,500 ft. below the Burns Hanger to protect oil string from corrosion in salt formation. Oil string is hung concentric with protective string for perfect cement job.

Burns Double Slip Hanger for Heavier, Longer Oil Strings. Utilizes Burns patented 100% contact safety slips.

A "rule of thumb" estimate in the oil fields indicates that savings with Burns Hangers by eliminating overlapped casing, labor, rigging time, etc. average approximately one-fourth the cost of completing a well. Your cement jobs come out perfectly and uniform in thickness. Get the complete story today. Check with us direct or consult a Burns distributor.

Burns Single Slip Hanger For Shorter Strings. Utilizes Burns patented 100% contact safety slips.



BURNS TOOL COMPANY

8346 SALT LAKE AVENUE — BELL, CALIFORNIA

M. D. "Bud" Rohders Co.
Farmington, New Mexico
Post Office Box 396
Phones: DAvis 5-9453 or 5-3773
Odessa, Texas
Phone: FEderal 7-0749

Thorson Oil Tools, Ltd.
7106 103rd Street
Edmonton, Alberta, Canada
Telephone 393 — 838

ALSO SOLD THROUGH SUPPLY STORES

MUD COSTS CUT $4,650 IN 17,500-FOOT WELL USING DU PONT CMC GRADE DM

Du Pont CMC minimizes fluid loss with low mud viscosity at much lower cost than refined CMC

One major oil company added Du Pont CMC to a fresh-water mud in one of three 17,500-foot wells in the same Gulf Coast field, and refined CMC to the other two. Mud costs at the well using Du Pont CMC were $4,650 and $4,250 lower, respectively, than costs at the other two wells. Mud viscosity was lower at the Grade DM well, with fluid loss about the same for all three wells.

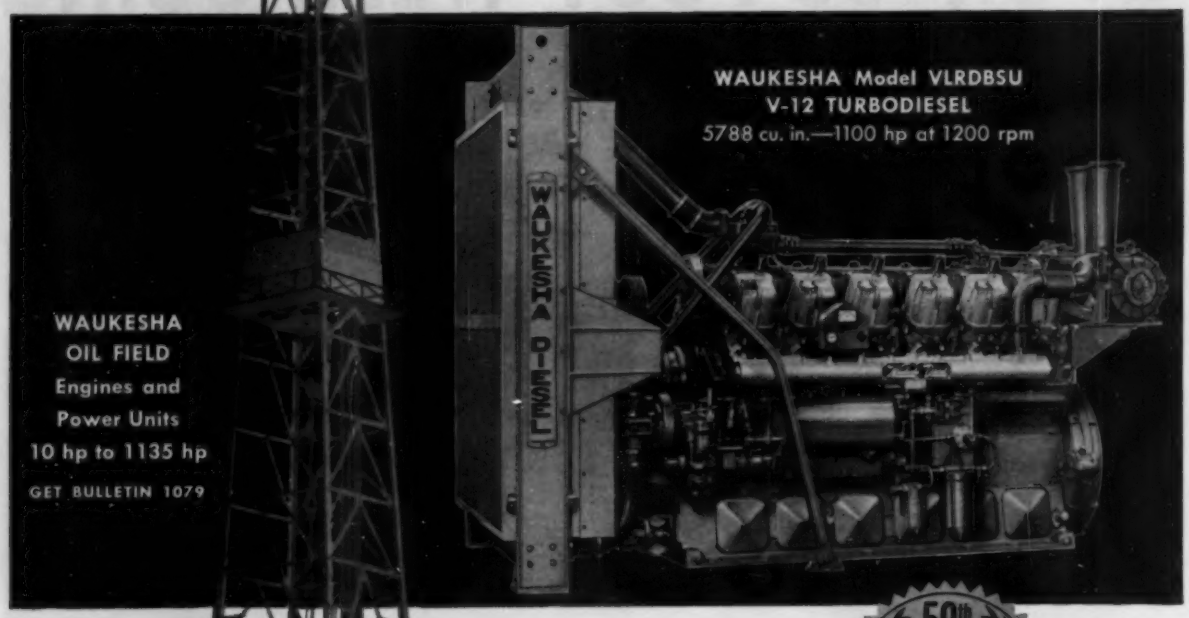
Cost savings like these, along with excellent fluid-loss control and low mud viscosity, are also reported from offshore wells. Versatile Du Pont CMC thins out sea-water mud systems . . . avoids the high mud viscosities often caused by starch in lime-treated muds. It resists thermal and bacterial degradation and can be used in high-temperature wells. Join the growing number of companies using Du Pont CMC Grade DM—you'll benefit from its economy and performance.

Ask for Du Pont CMC Grade DM from your mud dealer, or locations of Macco Corp. and Barada & Page, Inc., or from E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilson Building, 1621 Main St., Dallas, Texas, or Chemical Sales, Wilmington 98, Delaware.

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

FOR off-shore DRILLING



WAUKESHA
OIL FIELD
Engines and
Power Units
10 hp to 1135 hp
GET BULLETIN 1079

50th ANNIVERSARY
Waukesha MOTORS
1906-1956

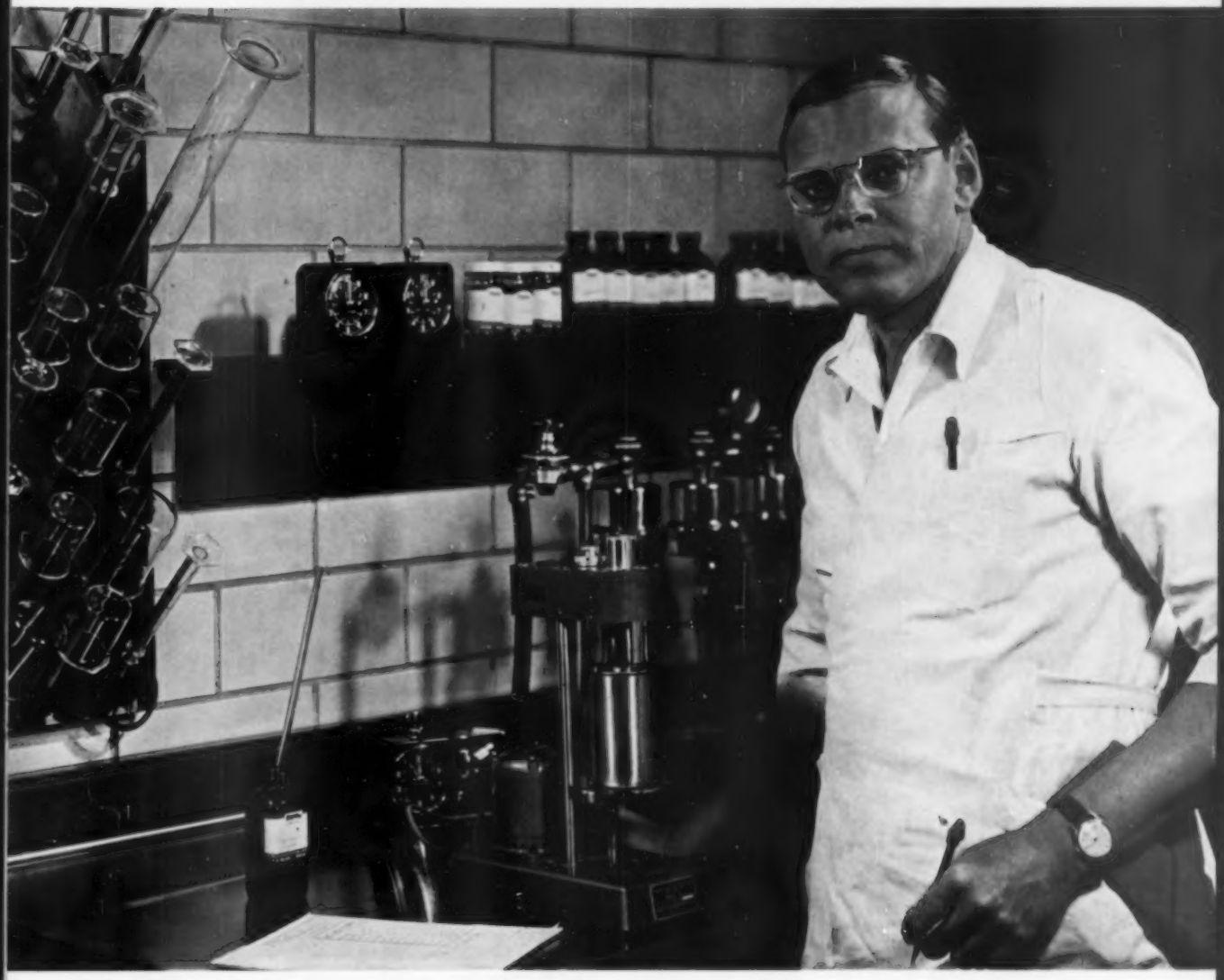
WAUKESHA

296

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN • NEW YORK • TULSA • LOS ANGELES

B-160

It takes a complete team to keep dependable drilling mud service available for you.



Meet this Magcobar Man, typical of drilling mud research engineers who literally live with your drilling problems.

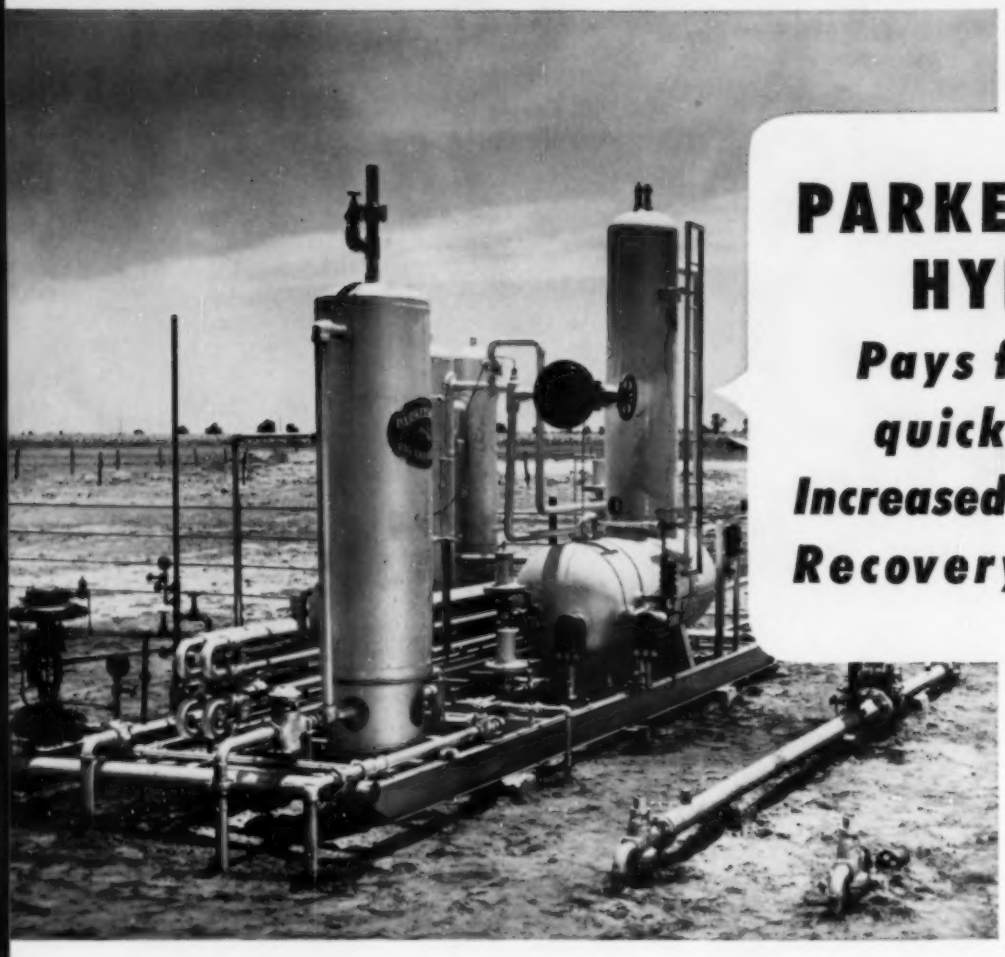
Drilling muds long ago passed the "earth and water" stage. In fact, progress has been the only constant thing. To keep ahead . . . to help solve many of your problems before they arise . . . Magcobar has reinvested a far greater percentage of its income in additional facilities and research than any other mud company.

It was in laboratories such as this, for example, where the industry's first 30 lb./gal. mud was developed, where water-in-oil emulsions were further perfected, and where Magcobar research engineers now work night and day to solve your drilling mud problems of the future. When you need mud today, look for the Magcobar Dealer sign. It is your assurance of the finest quality and the most complete service in the oil fields.

Magcobar
Complete
DRILLING MUD SERVICE

MAGNET COVE BARIUM CORPORATION

Houston, Texas



PARKERSBURG HYRECO

Pays for itself quickly from Increased Condensate Recovery Revenue

For profit-producing performance, a Parkersburg Hyreco has no peer. "Tailor-made" to fit your specific well conditions, it increases condensate recovery . . . substantially boosts revenue from gas wells . . . brings operating costs way down by its consistent trouble-free operation. No other unit can process high pressure gas at such low temperatures with less freezing trouble . . . no other unit pays for itself so quickly.

The Parkersburg Hyreco is available in capacities from 5 to 20 MMCF/D; pressures from 2000 to 6000 psi with either single tube or twin tube vertical knockout for liquid or water removal.

When you are ready for a processing unit it would more than pay you to discuss an "individualized" Hyreco with your Parkersburg Representative.

Parkersburg
RIG AND REEL COMPANY
DIVISION OF PARKERSBURG : AETNA CORPORATION

3345 WINTHROP AVENUE
FORT WORTH 16, TEXAS

5021

OPENS UP THE TOUGH ONES

HALLIBURTON'S

BIGFRAC

It takes more than a shove to make reluctant formations turn loose greater, steadier *volumes* of gas or oil . . . over longer periods of time. It takes a big jolt with bigger volumes of fracturing fluid at much higher rates. And that requires equipment with extra power and capacity. That's how Halliburton's BIGFRAC *delivers the pay-off punch.*

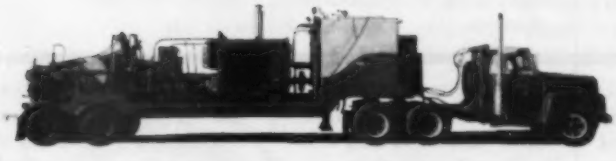
RELEASES PENT-UP PRODUCTION

BIGFRAC has substantially increased production from many gas and oil wells that have high total potential but are low in productivity. By creating more effective fractures, Bigfrac turns potential into pay-off in many different locations and types of formations.

BIG CAPACITY DOES A BIG JOB

Halliburton uses giant-size equipment to do a giant-size job. Thousands of horsepower drive high capacity sand proportioners and booster pumps, with tanks and wellhead connections to handle thousands of gallons of fracturing fluid and thousands of pounds of sand at rates up to 75 bbl/min. Continuously variable ratio controls provide accurate proportioning throughout the fracturing process.

High-volume Bigfrac jobs may sound expensive, but they actually cost less than you'd think—especially where the use of Halliburton's Sandoil or Vis-O-Frac is feasible—and that covers a lot of territory. Get maximum production from reluctant reservoirs with Bigfrac—the large-scale fracturing job with the pay-off punch. Call your local or district office of the Halliburton Oil Well Cementing Company.



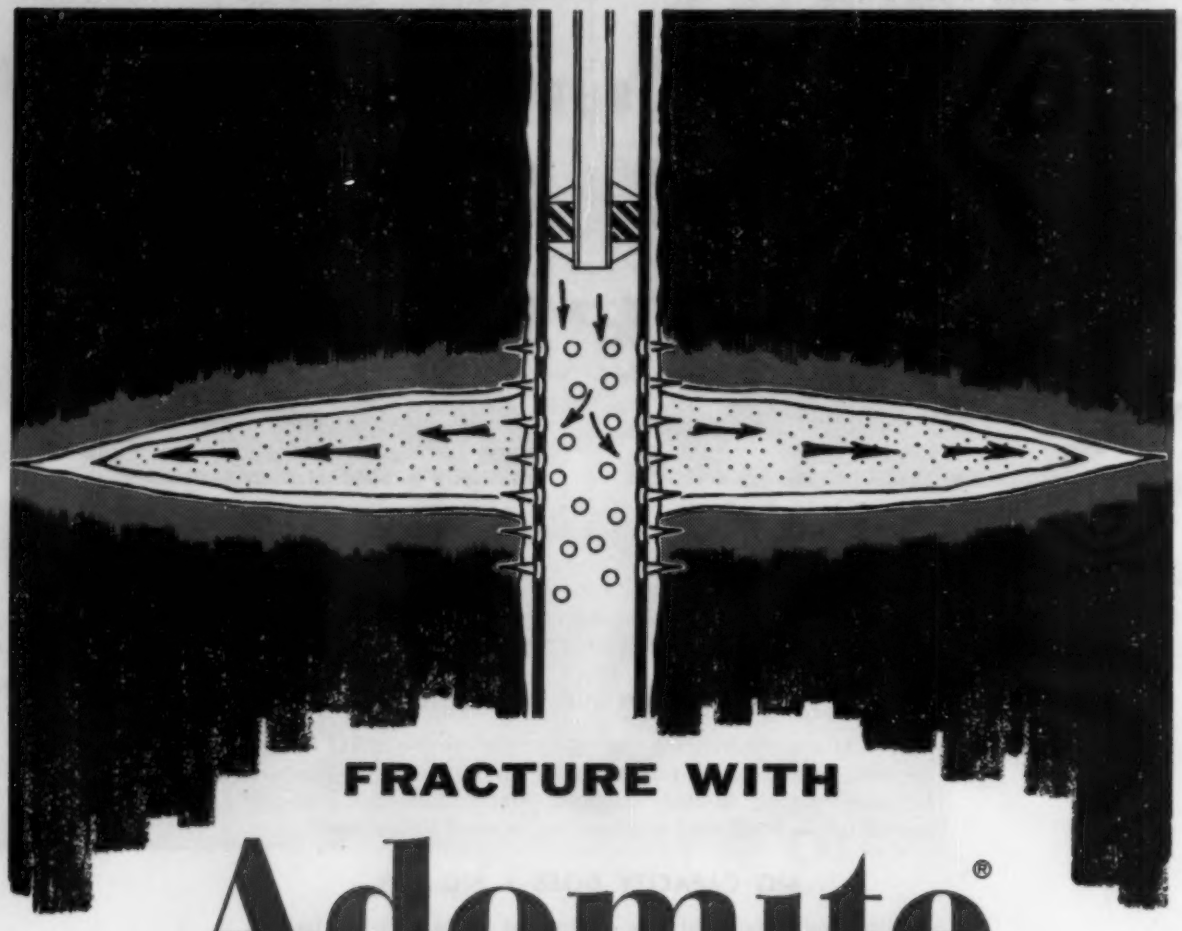
COMPLETE DATA SENT ON REQUEST

Add this valuable information to your Halliburton Service File

HALLIBURTON FRACTURING SERVICES

250 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

CUT FLUID LOSS TO A MINIMUM



FRACTURE WITH

Adomite®

Specify the fluid-loss control agent proven profitable in thousands of successful field treatments

Only Adomite gives you all these advantages— so effectively	Larger fracturing per volume of treatment—or the same size fracture with a lesser volume of fracturing oil.	Acceptance of fracturing fluid by pipeline companies —fracturing oils made from lease crude and Adomite are completely acceptable to pipelines.	Fewer sand-outs. Adomite prevents loss of fluid into the rock matrix, preventing buildup of sand concentration in the fracture.
Lower transportation costs. The fracturing oil costs you nothing when you use your own lease crudes.	Decreased friction losses. The low viscosity of Adomite-treated crudes or gelled crudes permits the use of less pumping equipment than viscous refinery residuals.	Compatibility of fracturing fluid with reservoir oils. Since Adomite is used with lease crudes, the fracturing fluid is fully compatible.	Fluid loss control with one additive. Adomite is all you need to control fluid loss of kerosene, crudes, gelled crudes or refinery residuals.

© 1956, Continental Oil Company

BE SURE TO TELL YOUR SERVICE COMPANY TO USE ADOMITE

Adomite—developed and manufactured by Continental Oil Company

Adomite®—trade-mark, Continental Oil Company

B-164

HOMCO
HOUSTON OIL FIELD MATERIAL COMPANY, Inc.

HAS IT-

COMPLETE DIRECTIONAL DRILLING SERVICE

Homco's **complete** Directional Drilling Service includes research engineering, development and manufacturing of a complete line of directional drilling tools.

Homco's Directional Drilling Engineers are experienced in every phase of Directional Drilling. Carefully selected men are given Homco's organized training program—extensive organizational and technical training in the classroom. These men then complete their training in the field under experienced directional drilling engineers.

Homco's combination of the best in modern directional drilling tools and methods in the hands of Homco's highly trained and experienced directional drilling engineers is your **best bet on any directional drilling job.**

THE WORLD'S LARGEST INDEPENDENT OILFIELD SUPPLY AND SERVICE ORGANIZATION

DIRECTIONAL DRILLING
•
FISHING AND CUTTING
•
OILFIELD SUPPLIES
•
ELECTRICAL WELL SERVICE

HOMCO
HOUSTON OIL FIELD MATERIAL COMPANY, Inc.

HOUSTON, TEXAS

Homco Export Division
509 Madison Avenue
New York, New York

THE OIL INDUSTRY'S MOST COMPLETE SERVICE

The right Axelson pump will give you more oil and less trouble.

Your J&L store has that pump and can prove its performance with local case histories.

Let J&L help. Axelson pumps are made and can be assembled in infinite variety. No J&L customer is ever obliged to use a square peg in a round hole.

Nor does J&L ever consider an Axelson sale final. J&L pump repair shops stand by in the United States and Canada with parts and service. Never junk an Axelson. Never accept a substitute.

Pump for more profit . . . get J&L on the telephone now.

J&L Casing and Tubing, Cabot Pumping Units, Axelson Sucker Rods — these are also select and important elements in the proven J&L formula for MORE OIL, LESS TROUBLE.

J&L

Profit Formula for Producers

MORE OIL LESS TROUBLE

Axelson deep well plunger pump, "TLE" tubing liner type.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

8-G

ONE OF THESE WECO UNIONS FITS YOUR NEEDS EXACTLY

Fig. 100
1000 psi
Sizes: 2"-8"

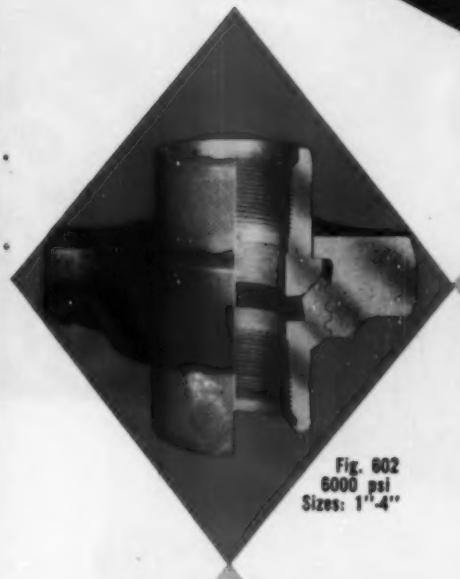


Fig. 602
6000 psi
Sizes: 1"-4"

Fig. 400
4000 psi
Sizes: 6"-12"

Fig. 400
4000 psi
Sizes: 2"-5½"

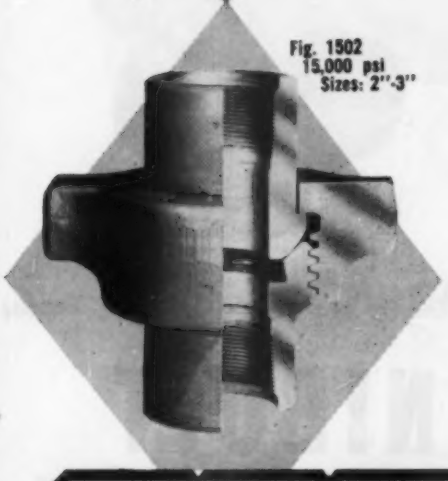


Fig. 1502
15,000 psi
Sizes: 2"-3"

Whether it's for high or low pressures on rig connections or production hook-ups, one of these Weco Unions, in sizes from 1" to 12", pressures from 1000 to 15,000 psi, is designed to do the job better . . . last longer . . . cost less in the long run.

Weco's ball and cone seat is unmatched for dependable leak-proof connections. The rugged Acme threads make-up and break-out fast and easy. The sturdier construction of Weco Unions takes the toughest service as a matter of course. They are available at supply stores everywhere.

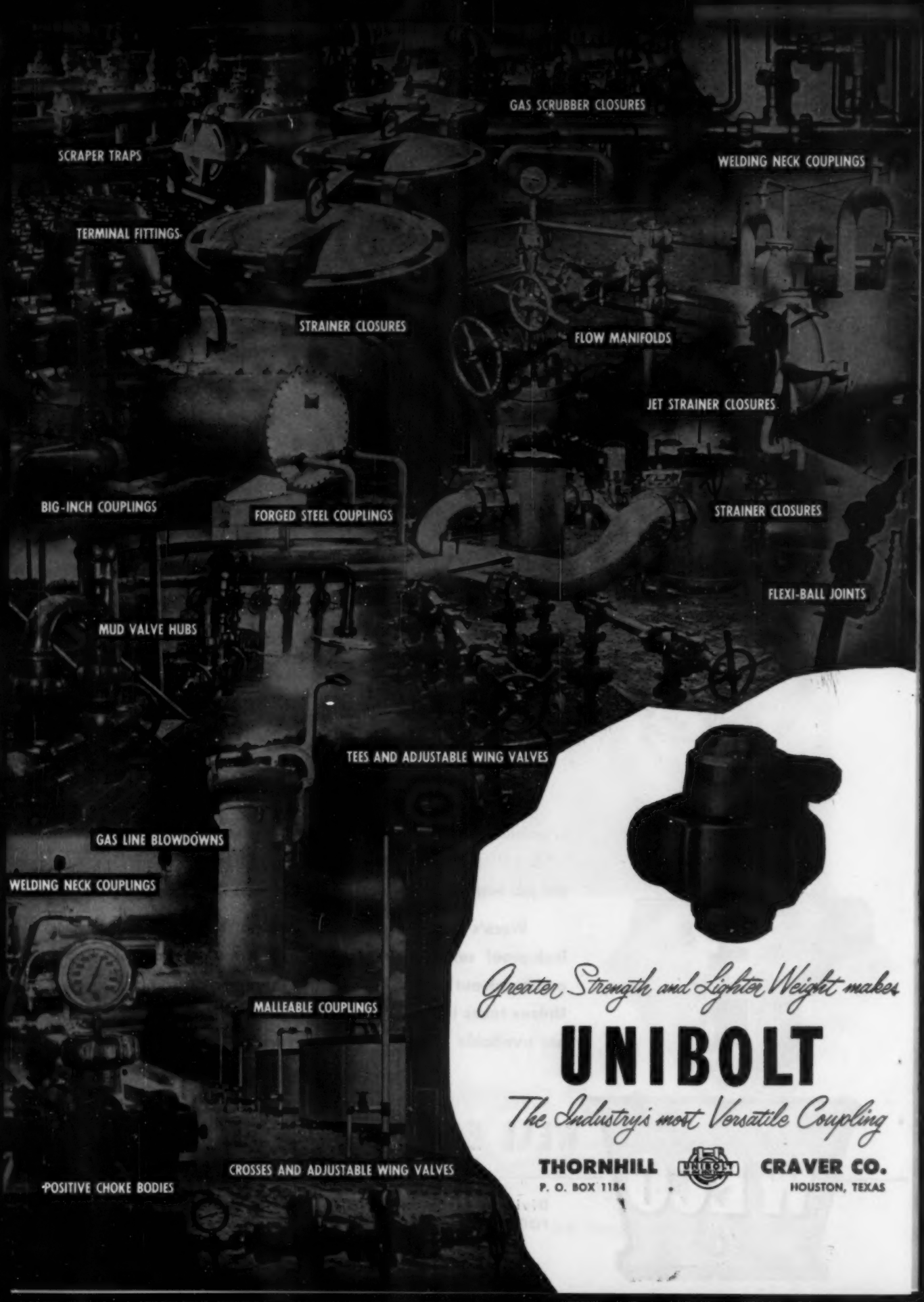
U-3-56

WECO®

WELL EQUIPMENT MFG. CORP.

HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of*
FOOD MACHINERY AND CHEMICAL CORPORATION



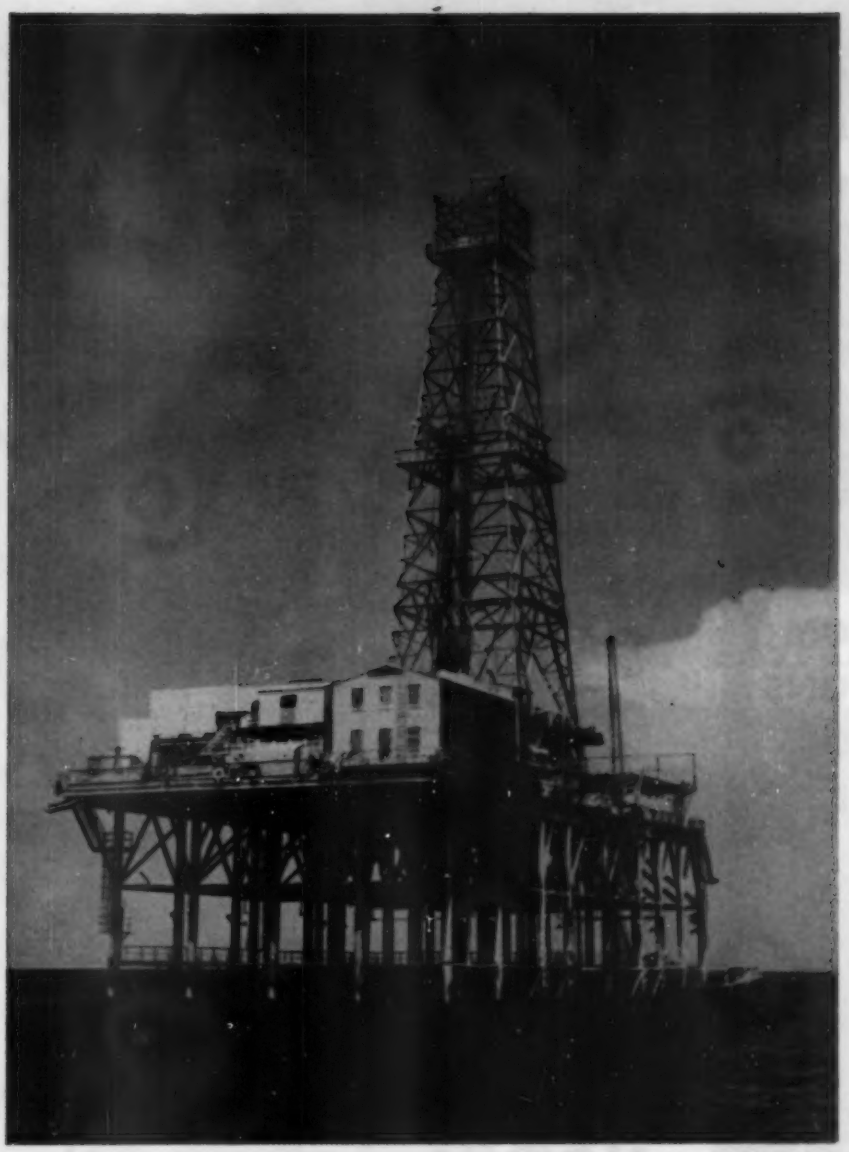
Greater Strength and Lighter Weight makes

UNIBOLT

The Industry's most Versatile Coupling

THORNHILL CRAVER CO.

P. O. BOX 1184 HOUSTON, TEXAS



OFFSHORE SOUTH LOUISIANA—Six wells are directionally drilled from this structure specially designed by Lee C. Moore Corporation.

General view of offshore drilling platform. Visible are drilling derrick, crew housing facilities, mud tanks and other equipment.

An offshore drilling giant moves out to sea. It is designed to operate in 100 foot water if necessary.

Variation of drilling platform with Moore Cantilever Mast.

Offshore

SPECIAL DRILLING STRUCTURE DESIGNS . . .

Lee C. Moore has the experience to serve you on the design and most efficient application of special structures for offshore work.

LEE C. Moore CORPORATION

TULSA: SHREVEPORT: GREAT BEND: CASPER: NEW ORLEANS: CENTRALIA: DALLAS: HOUSTON: MIDLAND: PITTSBURGH

EXPORT OFFICE: Room 624, International Bldg., 630 5th Ave., New York 20, New York

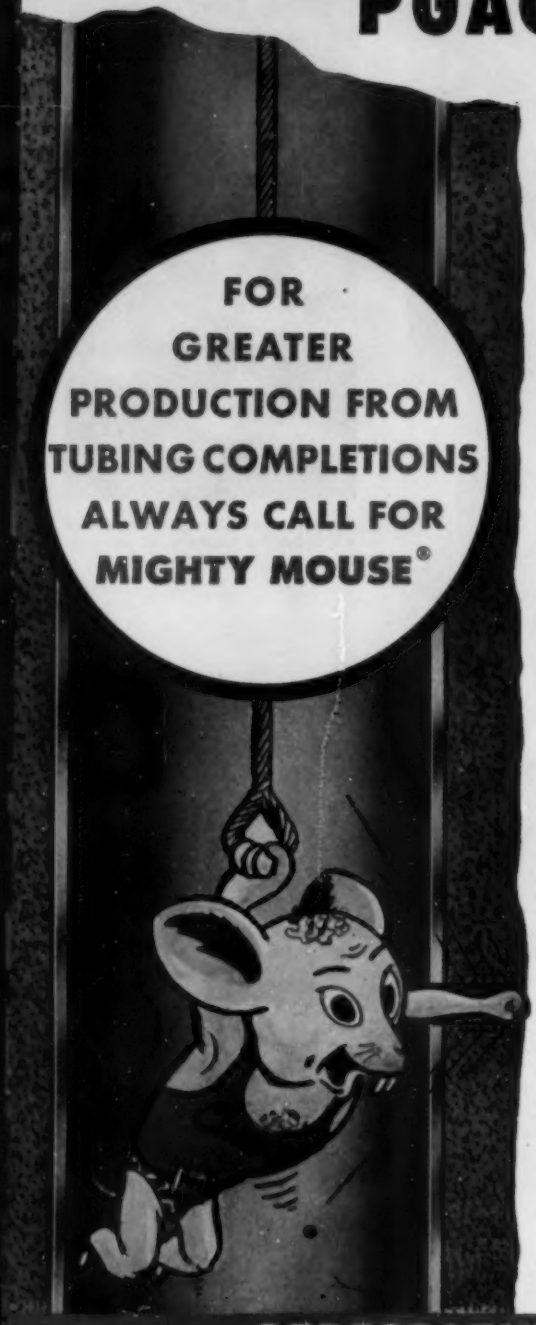
FOREIGN LICENSED MFR.: Oil Well Engineering Co., Ltd., Cheadle Heath, Stockport, England

9 FACTS

WHY YOU SHOULD DEMAND the *New* MIGHTY MOUSE®

PGAC's DEBRIS-FREE

EXPENDABLE 1¾" JET PERFORATOR



FOR GREATER PRODUCTION FROM TUBING COMPLETIONS ALWAYS CALL FOR MIGHTY MOUSE®

1. NOW, no carrot left to plug perforation after firing.
2. NOW, no gun debris remains in perforated zone after firing to obstruct subsequent operations.
3. NOW, shoots deeper, larger and cleaner holes than any other fixed 1¾" expendable gun.
4. NOW, semi-flexible gun permits passage through kinked or bent tubing.
5. NOW, larger fluid bypass area speeds running gun in well—allows passage through pump-seat nipples and tubing constrictions.
6. NOW, no over-all gun enclosure to leak fluid and cause misfiring—each charge separately contained.
7. NOW, unique safety features—firing initiated from bottom to determine completed operation.
8. NOW, penetration from this new 1¾" gun almost equals that from 4" O.D. guns.
9. NOW, optional use of 5 or 6 shots per foot reduces your tubing completion cost.

NOT "Lab Brags"

—but 9 FACTS

NOW PROVE WHY PGAC's NEW MIGHTY MOUSE IS STILL "CHAMP OF ALL THE MIDGET GUNS!"

PGAC 559

PERFORATING GUNS ATLAS CORPORATION

Houston, Texas Telephone REpublic 4-1651
General Offices and Main Plant: 7730 Scott Street—Sales Office: Melrose Building

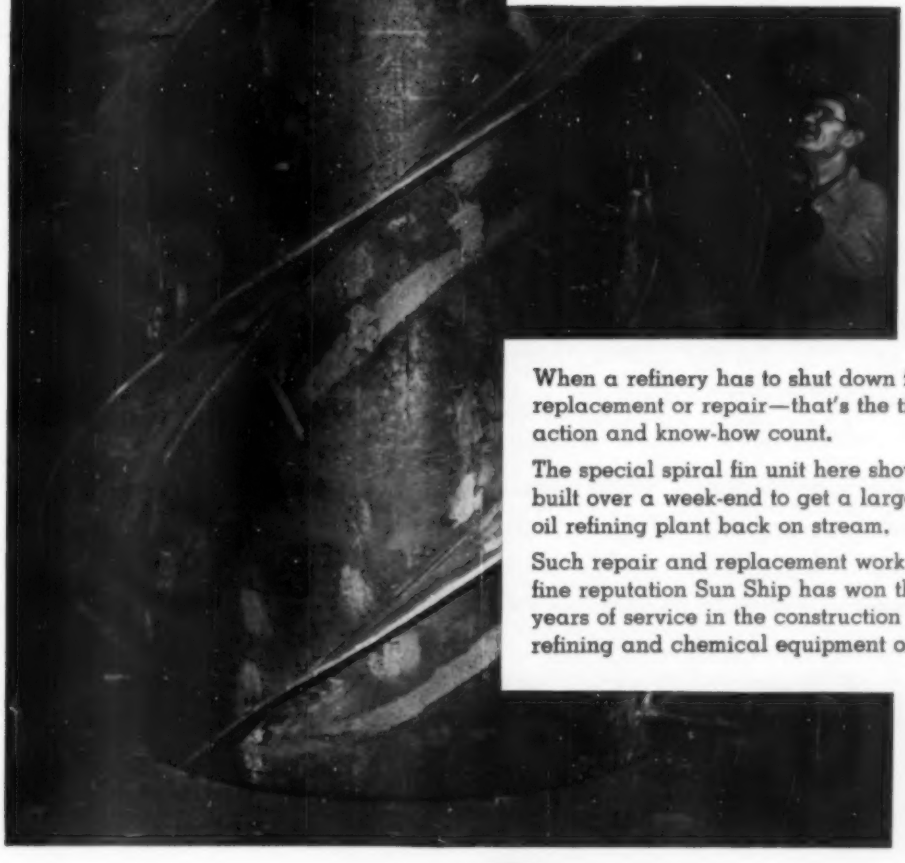
P G A C OIL FIELD SERVICES

CALL FOR PROMPT SERVICE—ALWAYS READY TO SERVE YOU

TEXAS: Abilene — Alice — Beaumont — Bowie — Colorado City — Corpus Christi — Dallas — Fort Worth — Gainesville Graham — Houston — Longview — Midland — Odessa — Pampa — Tyler — Victoria — Wichita Falls.
OKLAHOMA: Ardmore — Healdton — Oklahoma City — Pauls Valley — Pawhuska — Perry — Seminole — Tulsa.
LOUISIANA: Houma — Lafayette — Lake Charles — Shreveport. KANSAS: Great Bend — Liberal. NEW MEXICO: Hobbs.

AFFILIATE COMPANIES: CANADA—Perforating Guns of Canada, Ltd.; Edmonton, Alberta
GERMANY—Atlas Deutsch-Amerikanische Olfelddienst G. m. b. H.; Kiel VENEZUELA—Servicios Tecnicos Atlas, C.A., Caracas

FAST REPLACEMENT



When a refinery has to shut down for a replacement or repair—that's the time when action and know-how count.

The special spiral fin unit here shown had to be built over a week-end to get a large oil refining plant back on stream.

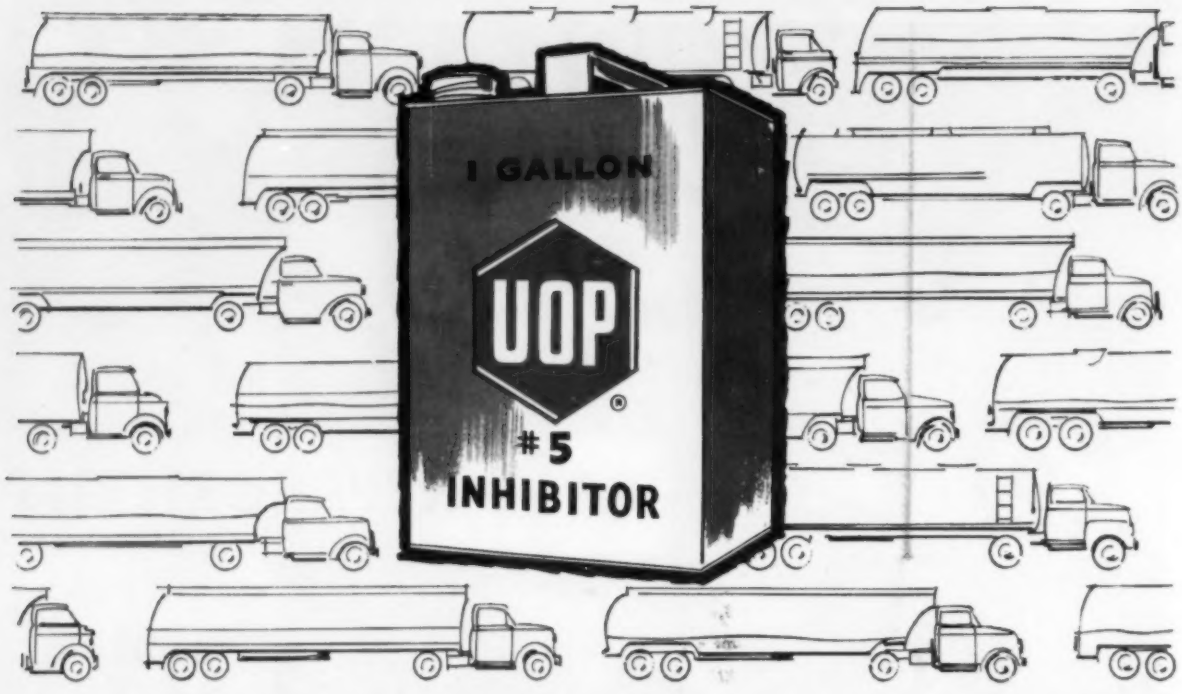
Such repair and replacement work has added to the fine reputation Sun Ship has won through years of service in the construction of oil refining and chemical equipment of every kind.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE (SINCE 1916) CHESTER, PA.

IT TAKES ONLY ONE GALLON OF UOP #5...



TO KEEP 100,000 GALLONS OF GASOLINE GUM-FREE

UOP #5 Inhibitor is the most economical you can use. And by experience and test it is also the best—the only inhibitor that can handle the really tough stability jobs.

Actually, only 5 molecules of UOP #5 will protect as many as 1,000,000 molecules of today's tailor-made gasoline from the formation of gum, the one universally recognized cause of engine manifold deposits. It's effective, too, in preventing the decomposition of TEL in stored gasoline. Is it any wonder that UOP #5 is the standard of comparison in the industry?

Just as the methods of making better gasoline keep changing, so do the techniques of finishing gasoline for maximum gum stability and engine cleanliness. We will be glad to share our experience in this field with you in attacking a current stability problem or in reducing costs on present processing. Just write us.

PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

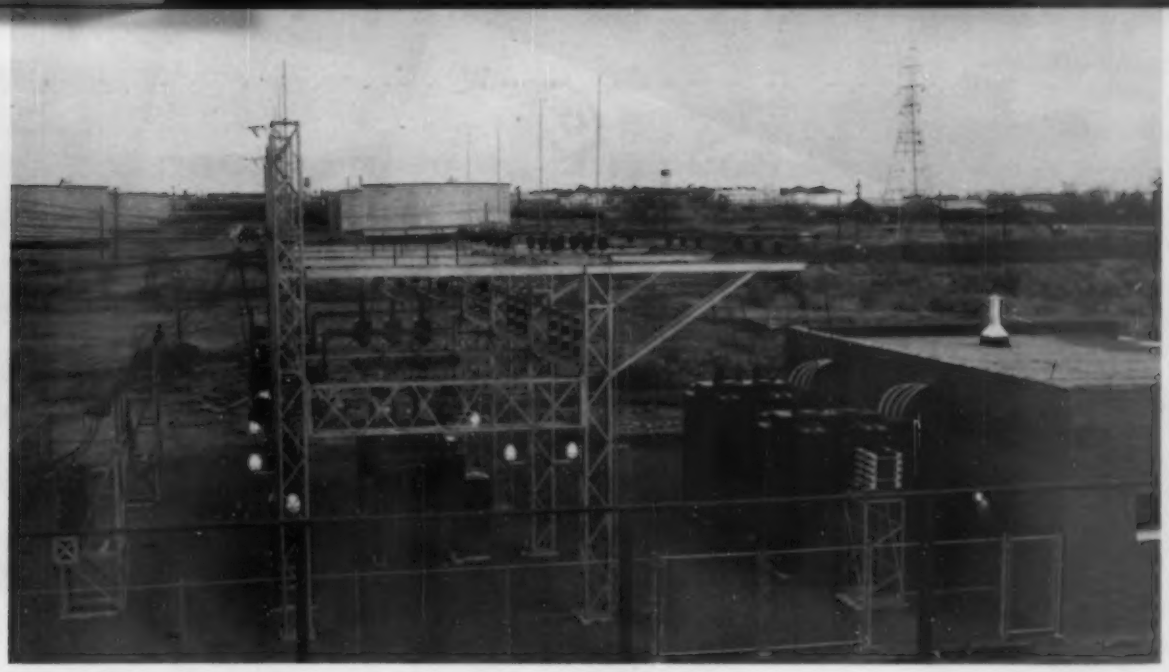


FIG. 1. Outdoor substation, where three lines connected to three independent power sources insure continuity of power supply. P 769.

Electrical System In New Petrochemical Plant

Selection of equipment and layout for this large plant show "the last word" in efficiency and flexibility

R. C. Berger
General Electric Company

ELECTRICITY, air and natural gas are the raw materials that produce agricultural fertilizers and industrial chemicals at Sohio's new $17,000,000 petrochemical plant at Lima, Ohio. Anhydrous ammonia and urea fertilizer compound are but two forms of agricultural nitrogen that are being produced for the Mid-Western agricultural states.

Electric Power Distribution and Utilization Equipment

In many cases, the design of a modern industrial power distribution system is a philosophy rather than a science. In the case discussed here, there were few compromises. Every major decision was made on the premise that a reliable distribution system is an insurance policy against lost production. For example, careful consideration was given to the selection of system voltage, the secondary selective system, the load-center system neutral grounding, selective circuit protection and provision for future growth.

Oil refineries and petrochemical plants are notable for their requirements for explosion-proof electrical apparatus when it is located in the area of volatile atmosphere. In this case, almost all of the 4160-v switchgear, load-center unit substations, Cabinetrol, Limitamp control, and excitation motor-generator sets are general purpose, indoor type located in a separate switch-house on the north end of the property and away from the explosive atmosphere. This decision resulted in a lower overall installed cost in spite of building costs and in the final analysis will effect a lower operating cost because of easier maintenance.

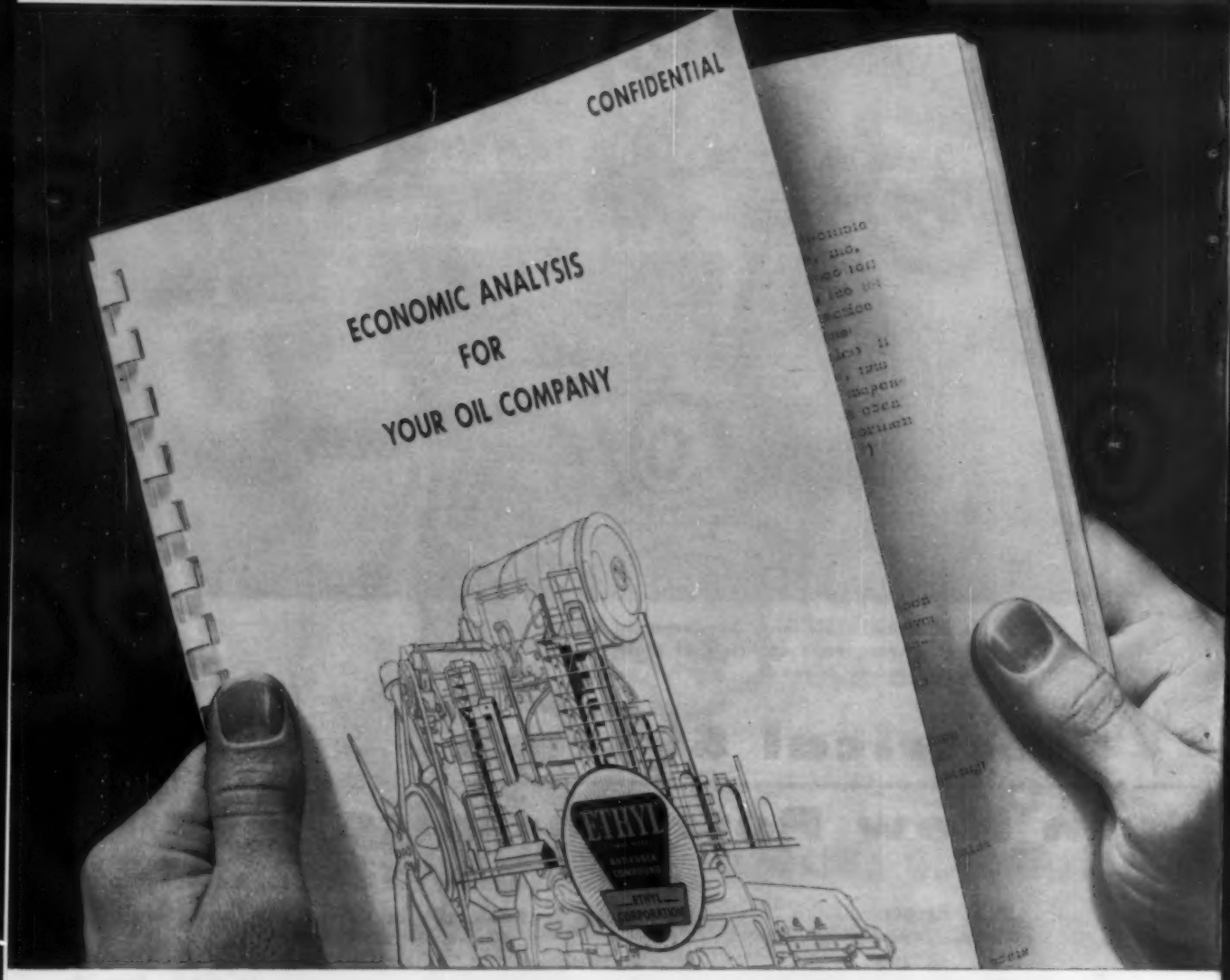
Selection of System Voltage

Power is supplied by the Ohio Power Company at a voltage level of 34,500 v, 3 phase, 60 cycle. For maximum service reliability, three separate lines serve the plant through the outdoor substation shown in Fig. 1. One line comes from West Lima Substation, the second from Sterling Substation, while the third line connects with the Sohio Refinery, which is located directly east of the petrochemical plant site.

At present, the system is split directly down the middle. From the 34.5-kv bus, the voltage is stepped down to the plant distribution and utilization level of 4160 v through a pair of 11,500 kva, self-cooled, oil-filled power transformers. Provision has been made for a future forced-cooled rating of 14,394 kva for each unit.

The secondary of each transformer is connected to separate 4160-v buses with a normally open tie-breaker between. The rating of the transformer was selected so that the future forced-air rating would exactly match the maximum rating of 2000 amp available in this class of switchgear. A special impedance of approximately 7 per cent was designed into the units to limit the monentary duty on the switchgear to a figure below the switchgear rating of 60,000 amp.

Selection of 4160 v for the distribution voltage to the large blowers and compressors was based on economics together with the fact that this was a good design voltage for motors of this rating. Motors rated between 1250 hp and 4000 hp utilize metal-clad switchgear for their control, whereas motors



Can we help you pinpoint your octane-improvement costs?

A dividend of $1,000 a day can be realized in a refinery producing 20,000 BPD of gasoline if the cost of that last octane number can be reduced 5¢ per research octane number barrel.

This is the type of cost reduction that Ethyl refinery technologists have been able to pinpoint for many refiners through economic analyses of process operations.

This assistance from Ethyl has taken various forms—from brief consultations to full-scale economic analyses. When called upon for a study, we work in close cooperation with your personnel. After the project is completed, we prepare a detailed report which summarizes and evaluates the data.

On the right-hand page you will find some examples of the type of studies we can do for you. You can enlist the services of our refinery technologists just by calling your local Ethyl representative. As always, these Ethyl services are available for the asking.

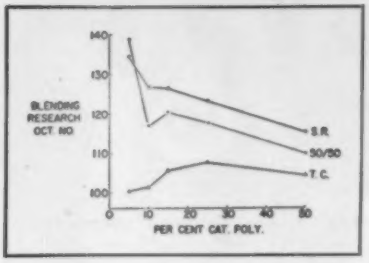
ETHYL CORPORATION
New York 17, N. Y.

Research Laboratories:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino Calif.

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

Economic Studies Ethyl Can Do For You

CATALYTIC POLYMER BLENDING BEHAVIOR



Here is a typical result of a simple blending study carried out at Detroit using laboratory facilities. Purpose of this study was to establish for the customer's use the blending behavior of catalytic polymer as a function of concentration in several refinery components.

COMPONENT BLENDING (ENGINEERING APPRAISAL)

I. INFORMATION REQUIRED OF CUSTOMER

A. Blending Basis

Component	B/D	RVP	RON Clear	RON 3M1/Gal
St. Run	1000	8.6	73.0	90.8
Th. Crack	840	7.4	75.8	87.4
Cat. Ref.	2320	6.1	84.7	95.5
Poly.	100	10.0	96.5	101.1

B. Products and Specifications
1. Volume Ratio—30% Prem., 70% Reg.
2. Volatility—Summer 9.0 RVP Max.
3. Octane Targets

These two tables are part of an engineering appraisal analyzing a refiner's octane situation. The information obtained enabled us to advise him on general solutions to his equipment and octane problems. Item 1 shows the type of information required of a refiner to make an engineering appraisal, i.e., his refinery operating basis and his product

2. DATA DEVELOPED
A. Laboratory Qualities of Individual Components
B. Inspection Data on All Blends
C. Fractionation of Specific Components

3. CALCULATIONS DEVELOPED
A. Optimum TEL
B. Optimum Premium Production
C. Maximum RON for Given TEL

4. END RESULT
A. Preparation of Report
B. Presentation of Report

objectives. Item 2 summarizes data we developed on the components submitted to us. Item 3 gives the calculations developed. In the course of an analysis of this type we may develop optimum TEL concentration for the given conditions, optimum ratio of premium-to-regular production and maximum RON attainable for a given TEL use.

ECONOMIC ANALYSIS OF REFORMING

I. GENERAL INFORMATION

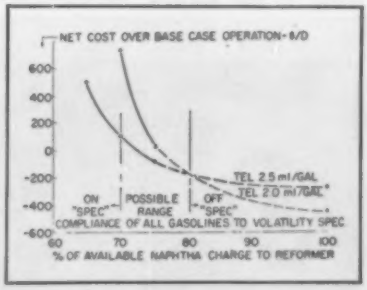
A. REFINERY
1. Crude and Gasoline Components —Quantity
2. Prem. — Reg. Gasoline — Ratio, Specifications
3. Cost Data—Prevalent Area Prices

B. LABORATORY
1. Gasoline Components—Qualities
2. Full Boil. St. Run Gasoline — Yield — End-Point, Octane, RVP Relationship

C. REFORMING
1. Products—Yield Octane Relationship
2. Operating Cost Analysis

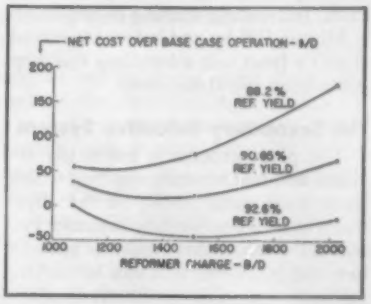
All of us realize the economic importance of TEL and the incentive for using TEL to maximum economic advantage. Outlined here is the information required to perform an over-all analysis for one of our customers. If the analysis happened to be for a refiner considering catalytic reforming, we could use typical catalytic reforming results and operating costs. Then we would construct a cost or operating pattern on which he could impose specific proposals as they are received from the process companies.

ECONOMIC ANALYSIS OF REFORMING (Constant Pool TEL Content)



We conducted this particular economic analysis to show a refiner how catalytic reforming would fit into his other operations. This figure shows cost in dollars per day vs. the per cent of available straight-run naphtha charged to the reformer. We show results at two TEL concentrations. Our studies indicated that this refiner will face a certain volatility problem. By this analysis, he learns he will have to charge between 70 and 80 per cent of his available naphtha to reforming and not get outside this range if he is to meet volatility imitations.

ECONOMIC ANALYSIS OF REFORMING (Variable Pool TEL Content)



For this customer analysis, net cost was plotted against reformer charge for various severities. Note that the minimum cost is obtained at the highest reformer yield; that is, at the lowest severity. Studies of this type illustrate the need for the refiner to study continually relative economics of TEL and reforming.

ALTERNATE USE ECONOMICS

VALUE OF CASINGHEAD

	Summer		Winter	
RVP – Casinghead	18	14	18	14
Value, ¢/gal	10.5	11.0	10.9	11.3
Effects:				
Gaso. up 1¢/gal	+0.8	+0.9	+0.9	+1.0
C_5 up 2¢/gal	+0.2	+0.1	+0.2	+0.1
Casinghead, Max. Bbls.	240	230	1055	1045
Gaso. Prod. Incr., Bbls.	205	215	970	1035

It is impractical for some companies to maintain a sufficient staff to permit making the many economic analyses required for most efficient gasoline operations. Recently, for a company in the South, we calculated values for certain gasoline components. (Table shows the value of casinghead gasoline.) Our refinery technology staff is in a position to make similar evaluations for you.

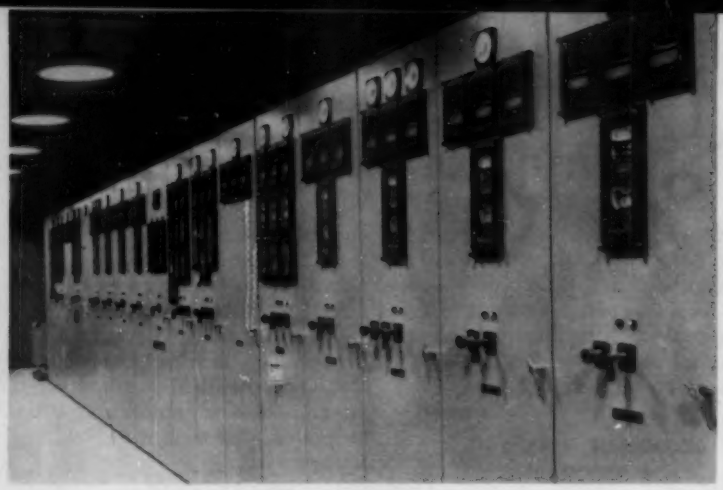


FIG. 2. 4160-v switchgear installation.

FIG. 3. The Limitamp controllers.

between 175 hp and 1000 hp are regulated by Limitamp controllers. In all cases, full voltage starting is employed.

Motors 150 hp and below are served at 480 v from unit substations that step down from the 4160-v level.

The Secondary Selective System

The plant process is essentially divided into two separate systems, which lends itself quite readily to the effective use of the secondary selective system. In essence, this system is actually two radial systems that can be tied together by means of a normally open tie-breaker. In the event of a failure in one system, the faulted transformer or cable may be switched out of service and the tie-breaker closed, which will maintain production at a decreased level. For almost every motor-drive on the system, there is an alternate on the other system. In general, in the process the corresponding pairs of motors operate in parallel. This results in an extremely reliable system and acts as excellent insurance against lost production. This philosophy was applied to both the 4160-v system and the 480-v system.

System Neutral Grounding

In order to minimize the effect of transient over-voltages and to reduce maintenance expense, the 4160-v systems are grounded through 2000-amp grounding resistors. These resistors limit the flow of ground fault current so as to minimize damage to faulted motors and other apparatus, yet sufficient current is permitted to flow in order to effect reliable ground fault relaying. The grounding resistors, one for each main power transformer, are of the stainless steel type suitable for outdoor installation near the associated power transformer shown in Fig. 1.

Provisions have been made on the load-center unit substations for solid grounding of the 480-v system by connecting the 4160-v winding in delta and the 480-v winding in wye, and by bringing the neutral to a bushing on the tank wall of the transformer.

Selective Circuit Protection

The relays on the high and medium-voltage systems and the tripping characteristics on the low-voltage system were carefully selected so that ground faults and phase faults can be detected and isolated close to the point of fault, thereby minimizing their effect on other parts of the system. In other words, in all cases the tripping of a feeder-breaker should not trip a main transformer, secondary breaker, as is often the case on a fully rated system or a cascade system. In this type of system, all circuit breakers at all voltage levels were selected for full short-circuit capacity.

Care was taken to limit the short-circuit current of 25,000 amp on the load-center unit substations since breakers with this rating offer best economy. In this instance, the short-circuit current was limited to 25,000 amp on the 1000-kva load-center substations by designing the transformers with a special impedance of approximately 8 per cent.

Provisions for Future Growth

Present capacity of the petrochemical station is 23,000 kva. This can be readily increased to approximately 29,000 kva by the addition of fans on the two main power transformers. Provisions have been made to add a third 11,500-kva, self-cooled transformer on a third 4160-v bus. This will increase the force-cooled rating of the substation to approximately 44,000 kva. Addition of the third power transformer will permit doubling the size of the present production facilities.

Present planning calls for a synchronizing bus arrangement when the third transformer is installed. Rather than three isolated systems tied together by two normally open bus tie-breakers, the three buses will be tied together through reactors to a synchronizing bus. This arrangement will permit large blocks of power to be tied together without operating the circuit breakers beyond their interrupting and/or momentary ratings.

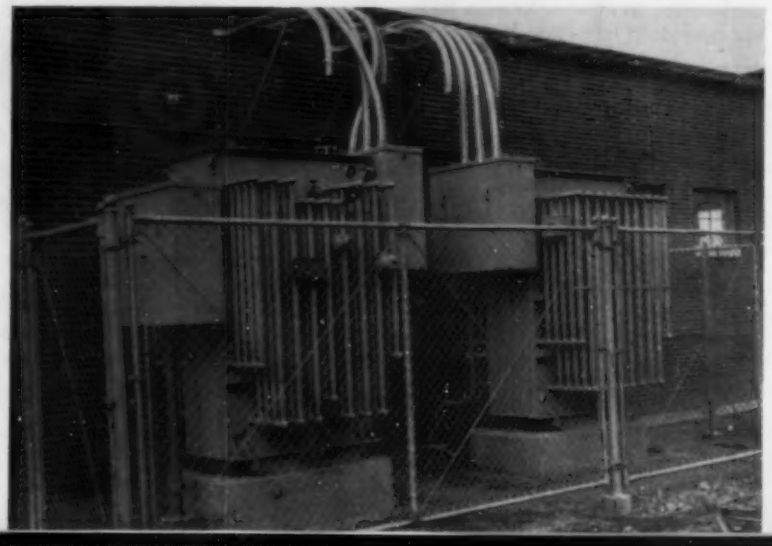


FIG. 4. The 480-v load center transformers, located outdoors.

FIG. 5. Low-voltage switchgear, the 480-v load center units.

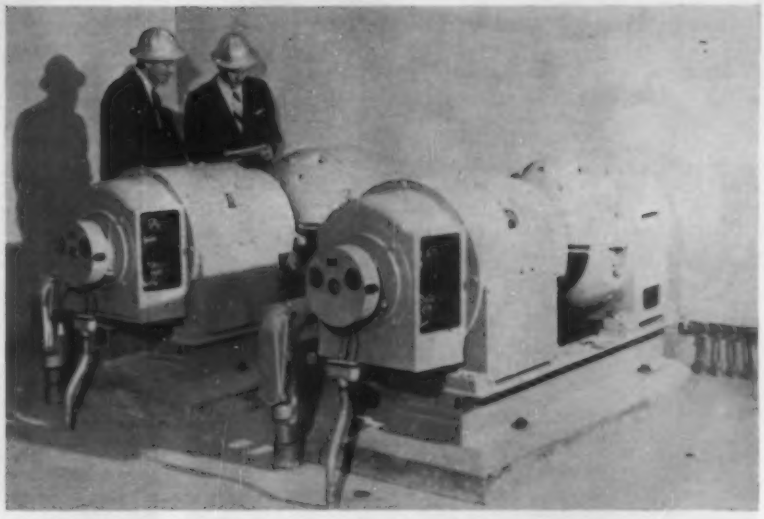


FIG. 7. 100-kw, d-c generators for exciting the synchronous motors.

The present system was planned and the circuit arrangements were selected with careful consideration for the future. Often as not, features can be incorporated in the initial planning stage at practically no increase in first cost.

Switchgear and Control Equipment

Circuit breakers on the 34.5-kv system have an interrupting rating of 1,500,000 kva. They are pneumatically operated, oil blast breakers.

The 4160-v switchgear located inside the switchhouse (Fig. 2) is equipped with electrically operated, vertical lift, magneblast (air) power circuit breakers. Each breaker carries an interrupting rating of 250,000 kva and a momentary rating of 60,000 amp.

Pilot wire relaying and directional overcurrent relaying is provided on each of the three incoming lines. The 34.5-kv bus is furnished with bus differential protection.

Each main transformer is protected by differential relaying in addition to overcurrent relaying. All large motors, 1250 hp through 4000 hp, are equipped with differential protection, overcurrent protection, over-temperature protection and under-voltage protection.

The Limitamp controllers (Fig. 3) control all 4160-v motors rated 175 hp through 1000 hp. Short-circuit protection is provided by means of Type EJ-2 current-limiting power fuses in combination with a 400-amp air-break contractor. This combination has an interrupting rating of 250,000 kva. Overcurrent protection is provided by overcurrent relays connected into the coil circuit of the air-break contactor.

The 480-v, load-center transformers are located outdoors along the south wall of the switchhouse, as shown in Fig. 4. Each transformer carries a self-cooled rating of 1000 kva. This rating can be increased to 1150 kva by the addition of ventilating fans.

Indoor low-voltage switchgear on the 480-v load-center units is located along the south wall inside the switchhouse as shown in Fig. 5. The low-voltage switchgear is arranged for secondary selective operation between the two 1000-kva transformers, and the circuit breakers are furnished with selective trips. The electrically operated circuit breakers are motor-starting breakers. Eight breakers (four on each transformer) control eight 125-hp, vertical, cooling-tower pump motors shown in Fig. 6. Two breakers, one for each transformer, control two 150-hp motor-generator sets for synchronous motor excitation. The manual circuit breakers are general feeders for some of the smaller loads in the ammonia plant, the steam plant, the

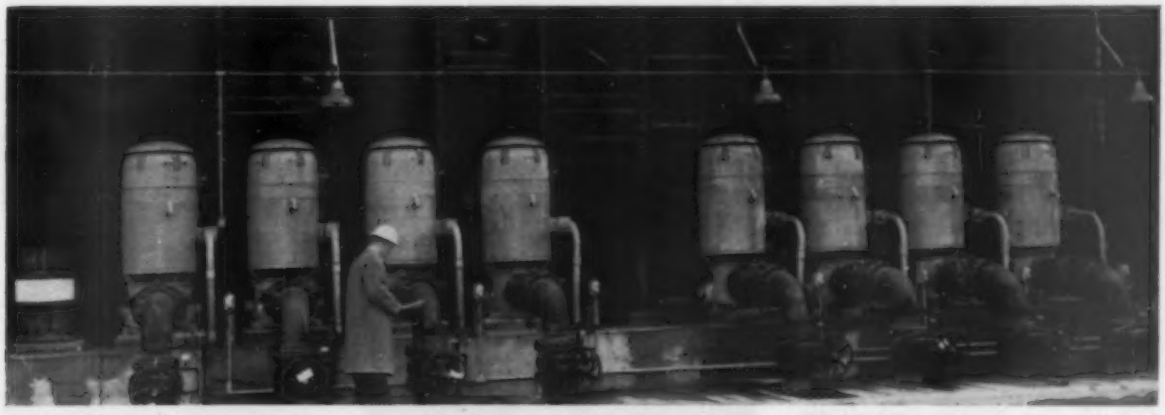


FIG. 6. Cooling tower pump motors, each controlled by a breaker.

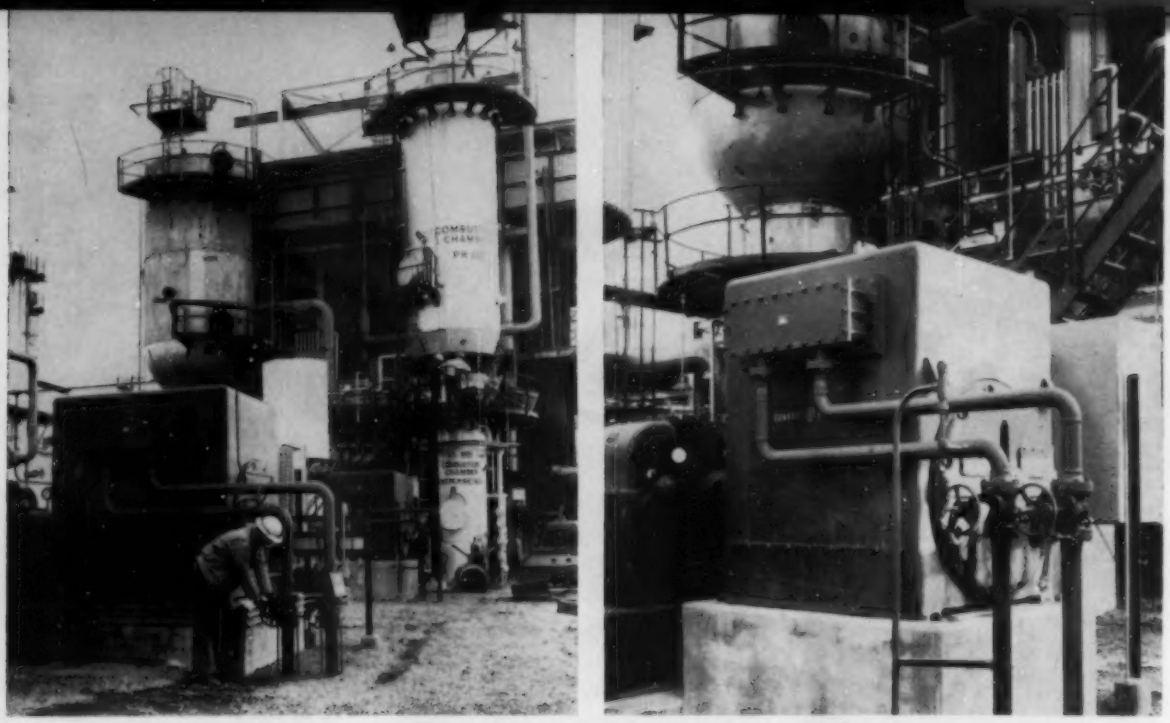


FIG. 8 and 9. A 4000-hp and a 2500-hp motor, each driving centrifugal blowers.

lighting transformers and some of the deep well pumps.

Close-coupled to one end of the low-voltage switchgear is the Cabinetrol equipment used for the control of five 75-hp, two-speed, reversing motors on cooling-tower fans. Each of these motors is protected by its own Trumbull molded-case circuit breaker having an interrupting rating of 25,000 amp.

Synchronous Motor Excitation

Excitation for the large synchronous motors, located in the compressor house, is obtained from a pair of 100-kw, d-c generators, shown in Fig. 7. The excitation requirements for all synchronous motors can be handled by only a single generator. The second generator, therefore, serves as a 100 per cent standby, thereby increasing the service reliability. Both generators are connected to a d-c excitation bus. From this bus, feeder-breakers distribute excitation to each of the nine synchronous motors. During normal operation, both generators divide the load equally between them. Each machine is equipped with a voltage regulator with cross current compensation for parallel operation. Reverse-current relaying is provided for each machine, and the generator-breakers are electrically interlocked with the motor-starting breakers located in the 480-v switchgear.

If for any reason it becomes necessary to shut down one of the generators for, say, maintenance or repair purposes, the total load can be transferred to one unit, and the other unit may be shut down without interfering with production.

Motor Features

The total connected load amounts to approximately 25,000 hp in motors. Of this, about 20,000 hp is made up of large blower and compressor motors. Two of these motors are induction motors rated 4000 hp and 2500 hp, both at 1800 rpm. These units, shown in Fig. 8 and 9, drive centrifugal blowers. Both of these motors are totally enclosed, air-filled, with air-to-water heat exchangers.

The compressor house shown in Fig. 10 is probably the largest concentration of electric utilization equipment in the plant. Two 3000-hp synthesis-gas compressor motors are shown in the foreground. They are rated at 300 rpm, .8 pf. Although all of these slow-speed compressor motors are open construction, nevertheless, the slip rings are all enclosed in explosion-proof housings.

Most of the electrical apparatus for the petrochemical plant was installed by the Dingle-Clark Company, Cleveland, Ohio. The investment in electrical apparatus amounts to approximately three-quarters of a million dollars. Site of the proposed plant was a golf course in Lima, Ohio, when the engineering started on January 6, 1955. The equipment was ordered and deliveries were completed by June 15, 1955. Power was delivered to the bus by July 14, and the first train load of agricultural fertilizers left Lima, Ohio, on Dec. 15, 1955. This is a story of close cooperation between customer, contractor and supplier. ★ ★ ★

FIG. 10. Two 3000-hp synthesis gas compressor motors.

Recovery of Refinery Slop Oil by Filtration

Antoine F. Alciatore
Dicalite Company

'Tough' emulsions are on increase in refinery waste; diatomite filtering speeds and improves separation

As petroleum refining processes become more and more complex each year, the resulting oil-water emulsions in refinery slops make oil recovery and waste water disposal increasingly difficult. Chemical treatment now fails to resolve these emulsions completely. In fact, interfacial emulsion layers are often formed by incomplete chemical breaking, and these create a further problem.

Breaking of oil-water emulsions by diatomite filteraids was mentioned in an early treatise on diatomite published in 1920; however, extensive use of this method did not develop until after World War II. Now a number of installations using this process are operating successfully in oil refineries. By filtration the emulsion-stabilizing solids are removed, and the ensuing passage of the oil and water through the extremely fine openings of a layer of diatomite filteraid breaks the emulsion. Completely separate layers of oil and water are obtained by settling this filtered effluent.

The positive action of this process is its major advantage. With increasing emphasis being placed on the prevention of stream pollution, positive resolving of emulsions (which would be one source of such pollution) is important in any refinery waste program. Most units operating today have been closely tied in with an overall refinery waste disposal program, the filtration phase being one important part of such a program.

While successful tests have been made with a stationary diatomite precoat in conventional pressure filters, the most successful application of this process involves filtering the oils or emulsions on a rotary vacuum precoat filter using a precoat of diatomite. Fig. 1 shows an installation of this type. Such filters, manufactured by Dorr-Oliver and Eimco Corporation, are made in various sizes up to 350 sq ft filtering area. The drum is first precoated (covered) with a layer of diatomite filteraid approximately 2 in. thick. This precoat is held on by vacuum and acts as the filter medium. After this precoat is applied, the diatomite cake is trimmed to a smooth, level cylindrical surface by manual operation of a horizontal knife blade.

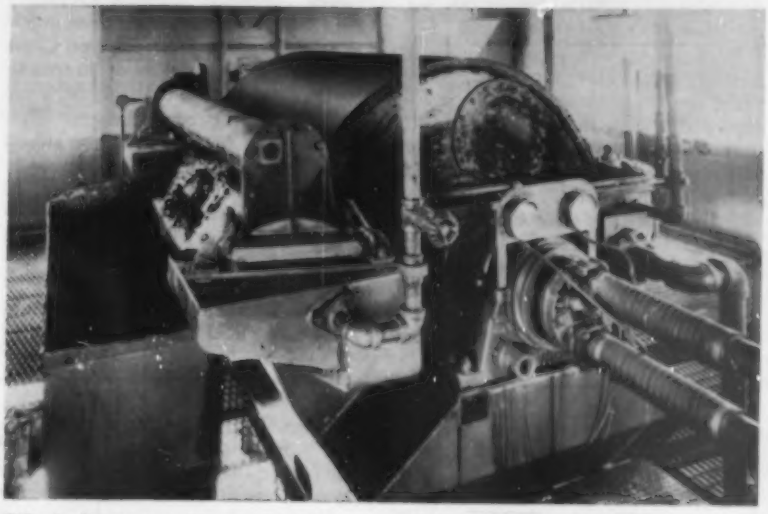


FIG. 1. Rotary vacuum precoat filter in operation filtering slop oil. This shows cake discharge side with shaved precoat shown falling into receiving bin.

The oil emulsion is then fed into the filter tank and filtration begins. Feed is usually controlled to mantain a liquid level slightly above the axis of the drum to obtain about 52 per cent submergence of the cylindrical filtering surface.

The clean surface from the knife cut rotates downward into the oil emulsion. As it moves through the oil, liquid is drawn by the vacuum on the inside of the drum through the cake, while the solids are retained on the surface.

As the coated surface emerges from the liquid at the back of the filter (opposite side from the knife), suction is continued and the surface becomes progressively drier as the drum revolves. With proper operating conditions, the surface loses its "shine" or free moisture shortly before reaching the knife blade. Here the solids are shaved off, together with a thin (.001 in. to .010 in.) layer of the precoat. The solids drop from the knife into a conveyor or water trough that carries them to the disposal point.

Meanwhile, the solids-free liquid is discharged from the interior of the drum through a ported valve on one end of the drum.

Thus, filtration and discharge of the solids and filtrate are continuous. Depending upon the depth of the knife cut and the speed of rotation of the filter, the cycle continues for from 10 to 36 hr, at which time the precoat has been shaved away until ½ in. to ⅝ in. thickness of "heel" remains. At this point, filtration is stopped, this precoat "heel" is removed, and the screen washed. The filter is precoated again and the cycle begins anew.

Initial studies for an installation of this type normally begin with the use of a standard test vacuum leaf filter. With this equipment, preliminary studies can be made on which to base further work with a larger unit. Pilot

plant studies employ a small precoat test filter about 2 in. wide by 12 in. in diameter. By their nature, slop oils vary widely in their filtration characteristics. The most important phase of preliminary test work is to be certain that the experiments are conducted on those oils that will be filtered on the full-scale installation to insure that the equipment is properly scaled. While high-permeability filteraids such as Dicalite 4200* show improved rates on certain types of oils, it is generally conceded by all operators that a filteraid of medium porosity such as Dicalite Speedplus*, having a water permeability of approximately 0.9 Darcies, is the one most suitable for all types of oils.

Filtration engineers have found that usually a great deal of time in the initial study can be eliminated if this is accepted and work limited to a filteraid in that range. The experience has been that plant installations have performed well within the limit of error of laboratory and pilot plant studies. Differences that did occur were mainly due to changes in the feed stock between test and actual practice. These changes were brought about not only by expected changes in the refinery slop due to process changes, but by later decisions as to what part filtration would play in the overall program and exactly what would be handled by the unit. Careful consideration should be given as to whether the filters should handle all slops and separator sludges, whether any chemical treatment should be employed, and the expected changes in nature and amount of emulsions and waste oil. Resolution of these points will help to make an installation of this type more efficient over a long operating period since the possibility of having the unit over-sized or over-loaded will be reduced.

The diatomite filteraids ordinarily used in this process are supplied in 50-lb paper bags shipped from West Coast producers in a minimum of 30 tons to the car. For storage calculations, a car of the material occupies between 3700 and 3900 cu ft, and it may be stored indefinitely without deterioration. After unloading, the material may be stored on pallets, a convenient size being 40 in. x 60 in. The bags are packed in seven layers at 3 bags per layer giving slightly over ½ ton per pallet.

From storage, the diatomite filteraid is fed to the filter either by means of an eductor or a slurry feeder. The eductor is an inexpensive method that gives a minimum degradation of filteraid during precoating. A slurry feeder, on the other hand, is advantageous from the standpoint of dust control, uniform feed rate, and ease of labor. During the precoating operation, the slurry should not contain more than 2 per cent filteraid by weight. This will give a filter cake of desired firmness without excessive cracking. The height of the slurry mixing and feeding tank should be 1½ times the diameter. For complete discharge of the slurry, the tank should have a convex or cone bottom. It is recommended that several baffles about 1/12 tank diameter be located along the lower half of tank walls; to prevent build-up on the baffles, they should be set out ½ in. from the walls. The slurry tank should be equipped with a mixer. A turbine type gives the highest degree of mixing and the least settling with the lowest horsepower input. An air suction system and dust hoods surrounding and above the area where the filteraid is dumped into the slurry mixing and feeding tank is warranted to control any dust raised in charging the tank.

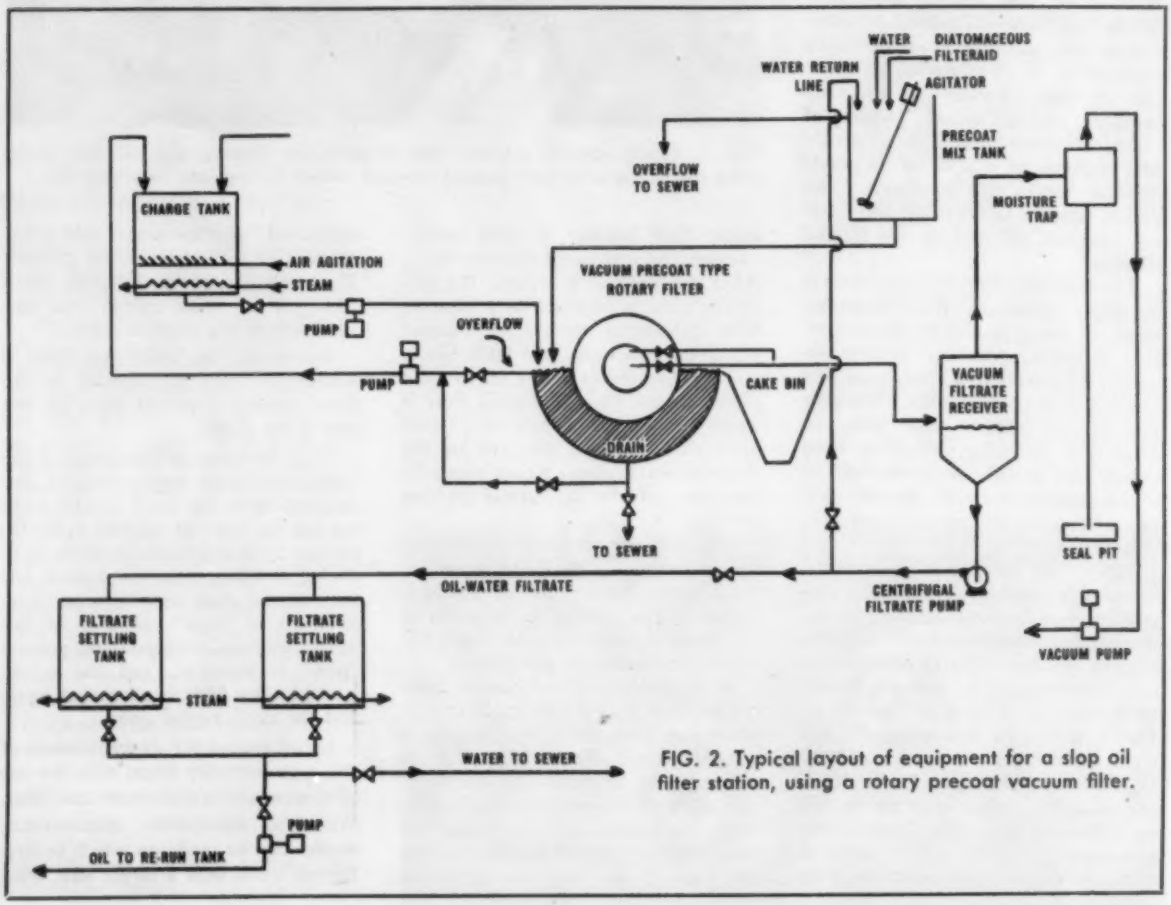


FIG. 2. Typical layout of equipment for a slop oil filter station, using a rotary precoat vacuum filter.

FIG. 3. A close-up view of the cake discharge side of a rotary vacuum precoat filter in operation. Cutting blade is hidden, but shaved precoat is seen clearly.

FIG. 4. An electron micrograph, 6000X, showing intricate particle structure and shapes of dicalite filter aid.

Precoating a filter should take about 45 min. The precoat is put on about 2 to 2½ in. thick at a temperature approximating that of the charge. The precoat should be relatively firm and even and show a negligible degree of expansion and contraction during the cycle. It is important to keep the screen on the filter drum as clean as possible. Uneven cakes may occur from reduced flow through areas of the screen plugged with dirt, or because of too rapid precoating flow, or due to the washing action of currents in the precoat liquor against parts of the drum surface. Small cracks in the cake are relatively normal and do not seem to affect the operation adversely. Large cracks may result in the cake falling off the drum. This occurs due to faulty technique mainly at the start-up, and quite often a skilled operator can pick up the cake for satisfactory performance. After the heel or last ⅜ in. of the cake has been dropped, the screen should be washed with a high-pressure water jet. Some experiments on a plant scale have been conducted to determine whether a part of the precoat heel could be used on the next precoat. At approximately ½ in. filtration was stopped and ⅛ in. of the heel shaved clean. Then a new precoat was put on over this, resulting in a saving of approximately ¼ in. of precoat each cycle. This has not met with much favor since the technique is involved and risks clogging the screen—usually outweighing the small advantage.

The actual filtration of the slop oil emulsion should be at approximately 180 F. Temperature is important as flow rates fall off sharply on some oils below 150 F. An oil filtering, for example, at 4.3 gal/ft²/hour at 180 F may run 4.0 gal at 160 F, but fall below 3 gal at 150 F.

The knife cut is ordinarily adjusted by the operators as they gain experience, the depth of the cut depending upon several factors, particularly upon the nature and the character of the solid content of the emulsion and the effluent rate required of the unit. An average knife cut of .0035 in. per revolution is normal, and in actual practice often runs about .0005 in. more than pilot plant averages for the same oil. In order to insure maximum efficiency with minimum filteraid consumption, the knives should be kept very sharp. They ordinarily run about three to four months of continuous operation between sharpenings. Dull knife edges result in an appreciable increase in filteraid consumption (up to 30 per cent).

Drum speeds average 120-180 sec per revolution. While the filtrate volume increases as the rotation speed is increased, 120-180 sec is good operating practice. This is usually controlled by the operator so that the discharged cake should be relatively dry. Where sufficient equipment is available, however, a drum speed of 340 sec may be used for more economical consumption of filteraid per gallon filtered. The average vacuum used on an operation of this type varies between 18 and 22 in. Experience has shown that a vacuum pump of sufficient capacity is a necessity on this operation. The ratio should preferably be 6 cfm to each square foot of filter surface.

Flow rates on slop oils vary, of course, with the solid content and the nature of the solids. In general, a slop oil gets more difficult to filter on aging. Flow rates vary from 1.6 gal/ft²hr for a high-solid difficult emulsion to as high as 10 gal/ft²/hr for an oil with less than 1 per cent solids. A typical oil would average 2.5 gal/ft²/hr on flow rate. Adding filteraid to the charge increases the flow rates and can be used when the unit is under production pressure. The amount of filteraid necessary, however, makes this generally uneconomical except where other considerations such as a capital outlay for additional filter equipment may be counted upon for partial justification. Average normal consumption of filteraid should approximate 2 lb per barrel of charge.

The discharged shaved precoat containing the emulsion-stabilizing solids that have been removed is relatively dry, having about 20 per cent water. This spent precoat may be removed dry to a dump or as a slurry. If pumped wet, the water may be removed by settling. The remaining residue may be sun-dried and burned in the open or incinerated.

The filter effluent will resolve into water and oil layers upon settling at approximately 150-170 F. Most charges with sediment approximately 1 per cent by extraction will yield a filtrate with sediment averaging .03 per cent reduction of 96 per cent average for all charges.

Plant installations have varied from single filter units installed outdoors to multiples of several filters as part of complete effluent stations. Each installation depends upon local considerations, varying with different processing conditions in each refinery.

It is likely that refinery processes will become even more complex in the future and that the amount of these difficult emulsions will increase. On the other hand, the tendency is toward stricter regulations concerning stream pollution. Since diatomite filtration has proved successful as a positive method of breaking the emulsions, the trend toward wider use of the process seems sure to continue. ★ ★ ★

EXCLUSIVE

New Viscosity Index

Part 2

En Route to Adoption

C. M. Larson and W. C. Schwaderer
Sinclair Refining Company

Summary

It has been shown that the VTI expresses and classifies by a single figure, the viscosity-temperature characteristics of lubricating oils and fluids, such as diesel fuels, kerosines, gasolines, alcohol and water. These characteristics are based on:

1. The concept of an "ideal" or permanent viscous series "P" as the logical limit. Based on this limit, the mathematical relationships with the present oil series give a greatly improved system for viscosity-temperature index rating, capable of extension both in Index units and Viscosity units far beyond the range of VI.
2. The use of only one real and perfectly adjusted straight reference series "R" properly classifying lubricating oils and characterizing the VTI behavior of "families" of oils. This series is described by a single formula representing the whole series and forming a straight line to the limits of the ASTM chart.

It is further shown that:

3. Anomalous values are avoided;
4. The sensitivity of the whole scale is distributed evenly;
5. The VTI is additive (prediction of viscosity of blends);
6. The VTI uses the Walther-ASTM function in common with the accepted ASTM Standard Viscosity-Temperature Charts. This function has been considered of fundamental importance, since it reflects the viscosity/temperature behavior of Newtonian liquids, including hydrocarbon and non-hydrocarbon lubricants.
7. The authors advocate the use of the inverted scale. The reasons for this are as follows:
   a. A viscosity-temperature index, as implied in the name itself, should express the susceptibility of viscosity to temperature changes, and the VTI indeed expresses this relationship by the mean relative temperature coefficient of viscosity in per cent over a given temperature interval.

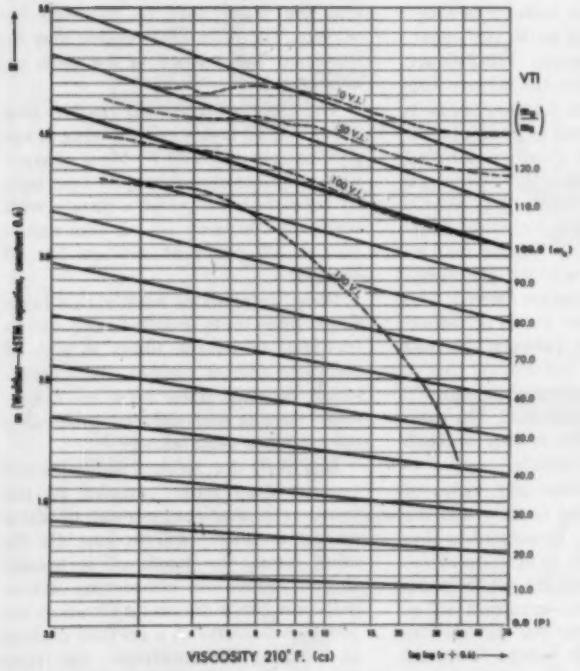


FIG. 5. Comparison of VTI "m" and ASTM-VI "m" curves.

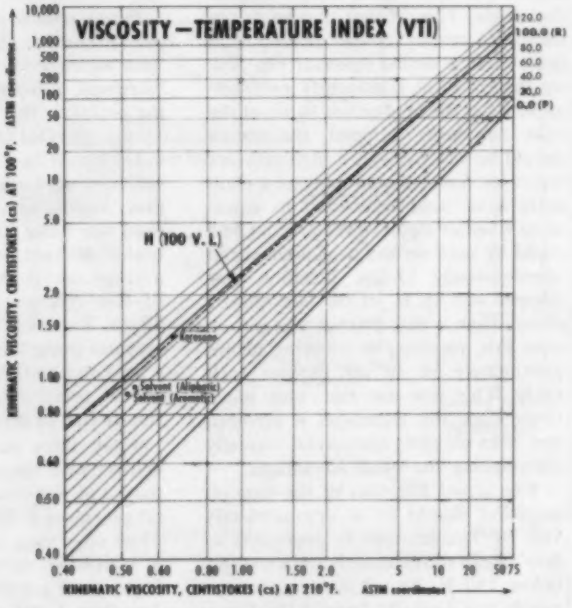


FIG. 6. Curves showing the extension of VTI down to the 0.4 centistokes/210 F viscosity.

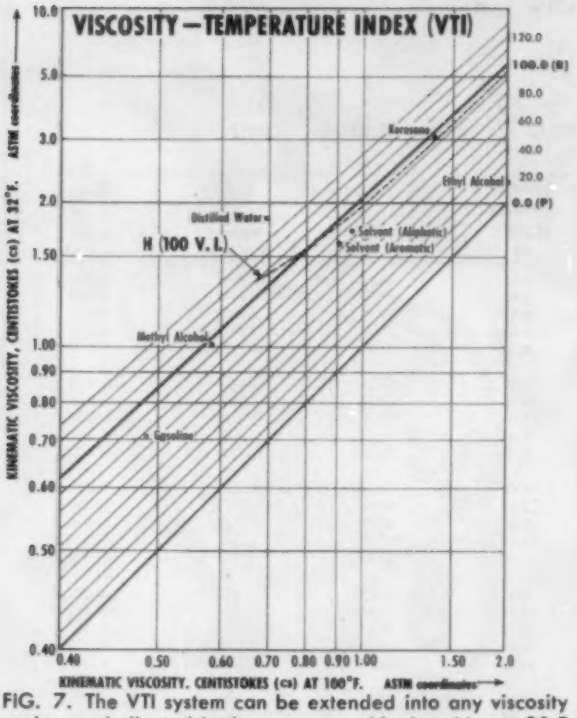


FIG. 7. The VTI system can be extended into any viscosity region, as indicated in these curves, with viscosities at 32 F plotted against viscosities at 100 F; this has not been possible with earlier viscosity-temperature concepts.

b. Fluids of the permanent viscous series "P" should be characterized by the figure 0 (not by some high number), thereby reflecting the unchanging susceptibility of viscosity to temperature. Thus, the inverted scale will relate nomenclature with physical characteristics of Newtonian fluids by assigning high index values to fluids of a relatively high rate of change of viscosity with change of temperature, and vice versa.

c. Negative values should be avoided and all normal liquids should have positive values. The present VI, unfortunately, assigns to normal oils both positive and negative values.

Modern research and development programs, as well as practical marketing considerations force us to make a mental readjustment, accustomed as we are to the old systems, when classifying lubricants according to their viscosity/temperature relations. The authors give a workable and practical solution to this perennially confusing problem.

PRACTICAL CALCULATION OF VISCOSITY-TEMPERATURE INDEX (VTI)

Formulas and Tables

Viscosity-Temperature Index (VTI) is calculated from the following equation:

$$VTI = \frac{\log\log(U + 0.6) - \log\log(v_{210} + 0.6)}{\log\log(R + 0.6) - \log\log(v_{210} + 0.6)} \times 100 = \frac{W_U - W_{210}}{W_R - W_{210}} \times 100 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where

$W = \log\log(v + 0.6)$ — See Equation 1 of the preceding section.

U = viscosity at 100 F of the unknown oil whose VTI is to be calculated.

v_{210} = viscosity of oil (P) of VTI "0" whose viscosity is independent of temperature, having the same viscosity at 210 F as the oil U whose VTI is to be calculated,
and

R = viscosity at 100 F of a reference oil R of VTI "100.0" having the same viscosity at 210 F as the oil U whose VTI is to be calculated.

Table 1

Values for W_R and W_{210} may be taken from Table 1 to avoid necessary calculations. It will then be necessary to determine only one double logarithm of the viscosity of the oil U plus constant 0.6 at 100 F ($W_U = \log\log(U + 0.6)$, to obtain the VTI value.

For General Use, Tables Containing Calculated VTI Indices Must Be Prepared.

Calculation and Reporting (with examples)

1. Determine the viscosity of the oil U at 100 F and 210 F and the W-value of U 100 F viscosity, which is equal to log log U + 0.6 (see examples). Table 1 gives the remaining values W_R and W_{210} corresponding to the 210 F viscosity of oil U, which are necessary for the calculation of the required VTI of the oil U by Equation 1.
2. Report the VTI to one decimal (calculate two decimals and correct the first decimal).

Examples (ASTM Designation D567)

1. Given Kinematic Viscosity at 100 F = 82.50 cs, and Kinematic Viscosity at 210 F = 9.10 cs. Find VTI.
   From Table 1: $W_R = 0.2731$
   $W_{210} = -0.0058$
   Find $W_U = \log\log(82.50 + 0.6) = \log\log 83.1$
   $\log 83.1 = 1.9196$
   and $\log 1.9196 = 0.2832$
   Substituting in Equation 1:

$$\frac{0.2832 - (-0.0058)}{0.2731 - (-0.0058)} \times 100 = \frac{0.2890}{0.2789} \times 100 = 103.62$$

   VTI = 103.6 (VI = 92.0)

2. Given Kinematic Viscosity at 100 F = 38.87 cs,
   and Kinematic Viscosity at 210 F = 5.86 cs.
   From Table 1 (by interpolation) $W_R = 0.1985$
   $W_{210} = -0.0914$
   Find $W_U = \log\log(38.87 + 0.6) = \log\log 39.47$
   $\log 39.47 = 1.5963$
   and $\log 1.5963 = 0.2031$
   Substituting in Equation 1:

$$\frac{0.2031 - (-0.0914)}{0.1985 - (-0.0914)} \times 100 = \frac{0.2945}{0.2899} 100 = 101.58$$

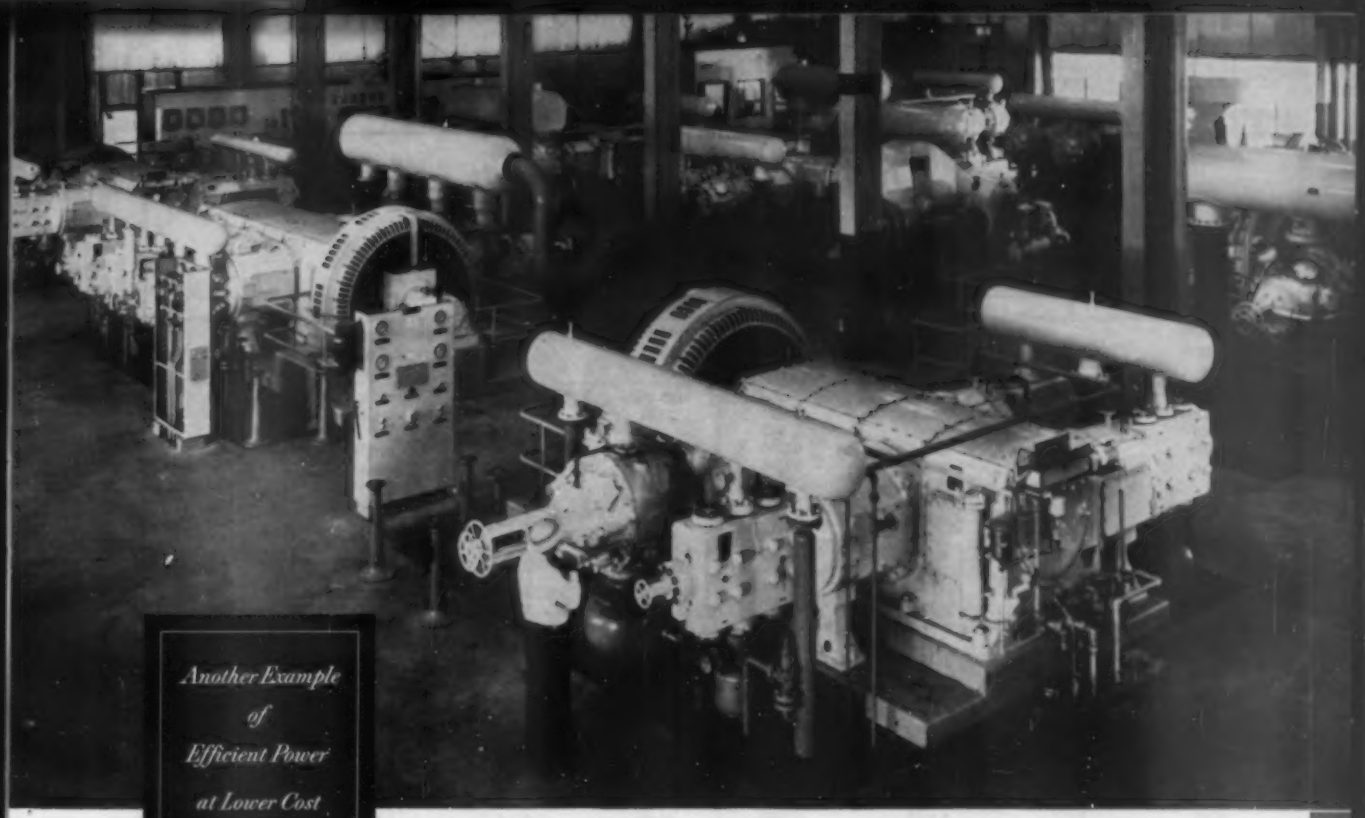
   VTI = 101.6 (VI = 104.0)

See Viscosity-Temperature Index Chart (Fig. 4) for the relation of VTI indices with the SAE numbers.

TABLE 1

BASIC VALUES (W_R, W_{210}) FOR CALCULATING VTI FROM KINEMATIC VISCOSITY

Kinematic Viscosity at 210 F. cs	R at 100 F. cs	W_R log log (R + 0.6)	W_{210} log log (V_{210} + 0.6)
2.00	7.024	−0.0545	−0.3820
2.10	7.574	−0.0398	−0.3652
2.20	8.139	−0.0262	−0.3495
2.30	8.718	−0.0135	−0.3350
2.40	9.311	−0.0017	−0.3214
2.50	9.92	+0.0094	−0.3086
2.60	10.54	0.0199	−0.2966
2.70	11.17	0.0298	−0.2852
2.80	11.82	0.0391	−0.2745
2.90	12.48	0.0480	−0.2643
3.00	13.16	0.0564	−0.2547
3.10	13.85	0.0644	−0.2455
3.20	14.55	0.0720	−0.2367
3.30	15.26	0.0793	−0.2284
3.40	15.98	0.0863	−0.2204
3.50	16.72	0.0929	−0.2127
3.60	17.47	0.0993	−0.2053
3.70	18.23	0.1055	−0.1983
3.80	19.01	0.1114	−0.1915
3.90	19.79	0.1171	−0.1849
4.00	20.59	0.1226	−0.1786
4.10	21.40	0.1279	−0.1726
4.20	22.22	0.1330	−0.1667
4.30	23.05	0.1379	−0.1610
4.40	23.89	0.1427	−0.1555
4.50	24.74	0.1473	−0.1502
4.60	25.60	0.1518	−0.1451
4.70	26.48	0.1561	−0.1401
4.80	27.36	0.1603	−0.1353
4.90	28.26	0.1644	−0.1306
5.00	29.17	0.1684	−0.1260
5.10	30.08	0.1723	−0.1216
5.20	31.01	0.1760	−0.1172
5.30	31.95	0.1797	−0.1130
5.40	32.89	0.1833	−0.1089
5.50	33.85	0.1867	−0.1049
5.60	34.82	0.1901	−0.1011
5.70	35.80	0.1934	−0.0973
5.80	36.78	0.1966	−0.0936
5.90	37.78	0.1998	−0.0900
6.00	38.79	0.2029	−0.0864
6.10	39.80	0.2059	−0.0830
6.20	40.83	0.2088	−0.0796
6.30	41.86	0.2117	−0.0763
6.40	42.91	0.2145	−0.0731
6.50	43.96	0.2172	−0.0699
6.60	45.03	0.2199	−0.0669
6.70	46.10	0.2225	−0.0638
6.80	47.18	0.2251	−0.0609
6.90	48.27	0.2276	−0.0580
7.00	49.37	0.2301	−0.0551
7.10	50.48	0.2325	−0.0523
7.20	51.59	0.2349	−0.0496
7.30	52.72	0.2373	−0.0469
7.40	53.86	0.2396	−0.0443
7.50	55.00	0.2418	−0.0417
7.60	56.15	0.2440	−0.0391
7.70	57.31	0.2462	−0.0366
7.80	58.48	0.2483	−0.0342
7.90	59.66	0.2504	−0.0318
8.00	60.85	0.2525	−0.0294
8.10	62.04	0.2545	−0.0271
8.20	63.24	0.2565	−0.0248
8.30	64.45	0.2585	−0.0226
8.40	65.67	0.2604	−0.0203
8.50	66.90	0.2623	−0.0182
8.60	68.14	0.2642	−0.0160
8.70	69.38	0.2660	−0.0139
8.80	70.63	0.2678	−0.0118
8.90	71.89	0.2696	−0.0098
9.00	73.16	0.2713	−0.0078
9.10	74.44	0.2731	−0.0058
9.20	75.72	0.2748	−0.0038
9.30	77.01	0.2764	−0.0019
9.40	78.31	0.2781	0.0000
9.50	79.62	0.2797	+0.0019
9.60	80.93	0.2813	0.0037
9.70	82.26	0.2829	0.0055
9.80	83.59	0.2845	0.0073
9.90	84.92	0.2860	0.0091
10.00	86.27	0.2875	0.0109
10.20	88.98	0.2905	0.0143
10.40	91.73	0.2934	0.0176
10.60	94.50	0.2963	0.0209
10.80	97.30	0.2990	0.0240
11.00	100.1	0.3017	0.0271
11.20	103.0	0.3043	0.0301
11.40	105.9	0.3069	0.0331
11.60	108.8	0.3094	0.0360
11.80	111.7	0.3119	0.0388
12.00	114.7	0.3143	0.0415
12.20	117.7	0.3166	0.0442
12.40	120.7	0.3189	0.0469
12.60	123.8	0.3211	0.0494
12.80	126.9	0.3233	0.0520
13.00	130.0	0.3255	0.0544
13.20	133.1	0.3276	0.0569
13.40	136.3	0.3297	0.0592
13.60	139.5	0.3317	0.0615
13.80	142.7	0.3337	0.0638
14.00	145.9	0.3356	0.0661
14.20	149.2	0.3375	0.0683
14.40	152.5	0.3394	0.0704
14.60	155.8	0.3413	0.0726
14.80	159.1	0.3431	0.0746
15.00	162.5	0.3449	0.0767
15.20	165.9	0.3466	0.0787
15.40	169.3	0.3483	0.0807
15.60	172.7	0.3500	0.0826
15.80	176.2	0.3517	0.0845
16.00	179.7	0.3533	0.0864
16.20	183.2	0.3549	0.0882
16.40	186.7	0.3565	0.0901
16.60	190.3	0.3581	0.0919
16.80	193.8	0.3596	0.0936
17.00	197.4	0.3611	0.0953
17.20	201.1	0.3626	0.0971
17.40	204.7	0.3641	0.0987
17.60	208.4	0.3655	0.1004
17.80	212.1	0.3669	0.1020
18.00	215.8	0.3683	0.1036
18.20	219.5	0.3697	0.1052
18.40	223.3	0.3711	0.1068
18.60	227.1	0.3724	0.1083
18.80	230.9	0.3737	0.1098
19.00	234.7	0.3750	0.1113
19.20	238.5	0.3763	0.1128
19.40	242.4	0.3776	0.1143
19.60	246.3	0.3789	0.1157
19.80	250.2	0.3801	0.1171



Another Example of Efficient Power at Lower Cost

This over-all plant view shows several of the compact Cooper-Bessemer M-Line compressor units that deliver dependable performance in the Brea Chemicals, Inc. modern ammonia plant near Los Angeles.

HERE'S MULTIPLE-SERVICE FLEXIBILITY IN MODERN AMMONIA PRODUCTION

. . with Cooper-Bessemer JM Compressors

● Twelve Cooper-Bessemer JM compressors, totaling 17,500 horsepower, are doing an efficient, economical job of handling a wide range of compressor services in the Brea Chemicals, Inc. 13-million-dollar ammonia plant near Los Angeles.

JM-4's for air, ammonia, mixed gas, hydrogen and recycle service, and JM-6's handling nitrogen compression, offer important savings to this producer of 235 tons of ammonia daily.

Here, to list but a few, are reasons why Brea, like so many other modern chemical producers, benefits from Cooper-Bessemer's century of compressing experience: there's extreme flexibility to handle a wide range of pressures and different gases, advanced design and metallurgy afford unusual strength and rigidity, there's five-step unloading at constant speed, the crankshaft is a steel forging of exceptionally large diameter thus low unit bearing pressures, compressor cylinder jackets are designed to insure adequate, uniform cooling, and the JM's exceptional compactness does not sacrifice accessibility or ruggedness.

If you're interested in compressing, write or call for full details . . . learn about *all* the plus features of these modern units. The nearest Cooper-Bessemer office will gladly cooperate.

MOUNT VERNON, OHIO

COOPER-BESSEMER

GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

TABLE 1 (Continued)

BASIC VALUES (W_R, W_{210}) FOR CALCULATING VTI FROM KINEMATIC VISCOSITY

Kinematic Viscosity at 210 F. cs	R at 100 F. cs	W_R log log (R + 0.6)	W_{210} log log (V_{210} + 0.6)
20.00	254.1	0.3813	0.1186
20.20	258.1	0.3825	0.1199
20.40	262.1	0.3837	0.1213
20.60	266.1	0.3849	0.1227
20.80	270.1	0.3860	0.1240
21.00	274.1	0.3872	0.1253
21.20	278.2	0.3883	0.1266
21.40	282.2	0.3894	0.1279
21.60	286.3	0.3905	0.1292
21.80	290.5	0.3916	0.1304
22.00	294.6	0.3927	0.1317
22.20	298.8	0.3938	0.1329
22.40	302.9	0.3948	0.1341
22.60	307.1	0.3959	0.1353
22.80	311.4	0.3969	0.1365
23.00	315.6	0.3979	0.1376
23.20	319.9	0.3989	0.1388
23.40	324.1	0.3999	0.1399
23.60	328.4	0.4009	0.1411
23.80	332.7	0.4019	0.1422
24.00	337.1	0.4029	0.1433
24.20	341.4	0.4038	0.1444
24.40	345.8	0.4048	0.1455
24.60	350.2	0.4057	0.1466
24.80	354.6	0.4066	0.1476
25.00	359.0	0.4075	0.1487
25.20	363.5	0.4084	0.1497
25.40	368.0	0.4093	0.1507
25.60	372.4	0.4102	0.1518
25.80	376.9	0.4111	0.1528
26.00	381.5	0.4120	0.1538
26.20	386.0	0.4128	0.1548
26.40	390.6	0.4137	0.1558
26.60	395.1	0.4145	0.1567
26.80	399.7	0.4154	0.1577
27.00	404.4	0.4162	0.1586
27.20	409.0	0.4170	0.1596
27.40	413.6	0.4178	0.1605
27.60	418.3	0.4187	0.1614
27.80	423.0	0.4195	0.1624
28.00	427.7	0.4202	0.1633
28.20	432.4	0.4210	0.1642
28.40	437.2	0.4218	4.1651
28.60	441.9	0.4226	0.1660
28.80	446.7	0.4233	0.1668
29.00	451.5	0.4241	0.1677
29.20	456.3	0.4248	0.1686
29.40	461.1	0.4256	0.1694
29.60	465.9	0.4263	0.1703
29.80	470.8	0.4271	0.1711
30.00	475.7	0.4278	0.1719
31.00	500.3	0.4313	0.1760
32.00	525.4	0.4347	0.1799
33.00	550.8	0.4380	0.1837
34.00	576.7	0.4411	0.1873
35.00	603.0	0.4442	0.1907
36.00	629.6	0.4471	0.1941
37.00	656.6	0.4499	0.1973
38.00	684.0	0.4526	0.2005
39.00	711.8	0.4553	0.2035
40.00	740.0	0.4578	0.2064
41.00	768.5	0.4603	0.2093
42.00	797.3	0.4627	0.2120
43.00	826.6	0.4650	0.2147
44.00	856.1	0.4673	0.2173
45.00	886.0	0.4695	0.2198
46.00	916.3	0.4716	0.2223
47.00	946.9	0.4737	0.2247
48.00	977.8	0.4757	0.2270
49.00	1009.0	0.4777	0.2293
50.00	1041	0.4797	0.2315
51.00	1072	0.4815	0.2337
52.00	1105	0.4834	0.2358
53.00	1137	0.4852	0.2378
54.00	1170	0.4869	0.2398
55.00	1203	0.4886	0.2418
56.00	1237	0.4903	0.2437
57.00	1270	0.4919	0.2456
58.00	1304	0.4935	0.2475
59.00	1339	0.4951	0.2493
60.00	1373	0.4966	0.2510
61.00	1408	0.4981	0.2528
62.00	1443	0.4996	0.2544
63.00	1479	0.5011	0.2561
64.00	1514	0.5025	0.2577
65.00	1550	0.5039	0.2593
66.00	1587	0.5052	0.2609
67.00	1623	0.5066	0.2624
68.00	1660	0.5079	0.2639
69.00	1697	0.5092	0.2654
70.00	1735	0.5105	0.2669
71.00	1772	0.5117	0.2683
72.00	1810	0.5129	0.2697
73.00	1848	0.5141	0.2711
74.00	1887	0.5153	0.2725
75.00	1925	0.5165	0.2738

Acknowledgment

The authors wish to express their gratitude to P. Skerchock, Sinclair Refining Company, New York, for his assistance in the preparation of this paper. The authors are also greatly indebted to Kurt K. Rumpf, Oelwerke Julius Schindler, G.m.b.H., Hamburg, Germany, and Dr. G. H. Goettner, Institut Fuer Erdoelforschung, Hanover, Germany, for their valuable suggestions given in their presented discussions of the VTI. The table for calculation of the VTI was prepared with IBM machine by the Sinclair Research Laboratories, Harvey, Illinois.

EXCLUSIVE

Addition Agents for LUBRICANTS

Part 3

C. J. Boner

Chief Research Chemist, Battenfeld Grease & Oil Corporation

V. I. Improvers for Lubricating Oils

While the ideal lubricating oil, that is, one that will not change its viscosity with temperature, has not been found, the viscosity-temperature curves of such fluids can be benefited by the use of V.I. improvers. These additives are long-chain polymers, of compounds such as alkylated styrenes, butylene, or esters of methacrylic acid. Some of those that are available include: "Acryloid HF and 710" (Rohm and Haas Company); "Paratone" and "Paratone W" (Enjay Company, Inc.); and "Santodex" (Monsanto Chemical Company).

The proportion of such additives required depends upon the original V.I. desired, and the specific oil since all lubricating oils of the same initial V.I. will not require the same percentage. Generally, from 1 to 7 per cent of V.I. improver is added. The larger amount will be found in multi-range oils, such as SAE 5W-20 grades.

It should be kept in mind that often additives used for some other purpose will also act as V.I. improvers. Little benefit, if any, is derived from such improvers when they are included in lubricating greases.

When subjected to agitation and shear in services, the polymers are subject to degradation in that they may be broken into shorter chain polymers. For this reason, they may lose some of their effectiveness. Hamer *et al*[8] tested two oils containing V.I. improvers and each having a viscosity of 48 SUS at 210 F. After a run equivalent to 1200 miles in a laboratory test engine, the first oil had decreased about 2 to 2½ sec in viscosity and the second oil had decreased 4 to 10 sec in viscosity.

The reason V.I. improvers are effective may be due to the fact that at low temperatures (up to 100 F), the polymers are not in solution but only colloidally dispersed. As the temperature increases (above 210 F), the polymers go into solution, in which state they increase the viscosity of the solution.

According to Hamer *et al*,[8] oils containing V.I. improvers will show lower oil consumption than oils of similar SAE rating but of somewhat lower V.I.

Pour Depressants

Certain polymers, when added to wax-containing lubricating oils in proportions of 0.1 to 5 per cent, will alter the crystal structure of the wax and thus permit movement of the oil at much lower temperatures than before the addition. Some additives used for other purposes may have a similar influence upon pour points.

Pour depressants normally used include: "Acryloid 150" (Rhom and Haas Company); "Paraflow PDX or 46X" (Enjay Company, Inc.); or "Santopour" (Monsanto Chemical Company).

Such additives have their largest usage in crankcase oils and apparently have no influence on thickened lubricants such as lubricating greases.

Oiliness Agents

While we do not have a measure of oiliness of a lubricant, the term is used to designate differences in the friction resulting when different lubricants are used under the same conditions. Fats or fatty acids have been added to lubricating oils to increase their oiliness. Thus, at one time about one-half a per cent of oleic acid was added to certain motor oils.

Aobut 3 per cent of "Alox 162" (Alox Corporation) is recommended as a lubricity agent in mineral oils. This is said to be a mixture of esters and other oxygenated hydrocarbons.

Some marine and steam-cylinder oils have animal or vegetable fatty oils added to them that should contribute to oiliness in addition to other characteristics. About 5 per cent of lard or tallow oil is sometimes added to oils

TABLE 7. Available extreme-pressure additives.

Additive	Per cent Cl	P	S	Zn	for MIL-L-2105	Cost per pound	Weight per gallon
Anglamol* 73A	32.0	—	6.0	—	10.0	—	—
Anglamol* 88	20.0	0.3	4.8	—	9.0	0.2660	9.2
Anglamol* 85	19.0	0.2	6.7	—	8.75	—	9.15
Parapoid‡ 10C	29.4	—	5.8	—	—	—	—
Santolub** 22	—	—	—	—	5.5	0.3775	—
Santolub** 29	24.0	0.56	8.5	—	6.5	—	9.1
Santolub** 32	26.0	0.56	8.2	—	6.5	—	9.9
Santolub** 33	26.0	0.55	8.5	—	6.75	0.3305	9.5
Santolub** 44	27.5	1.5	12.1	1.6	10.0	0.3475	9.8
Dibenzyl disulfide	—	—	26.5	—	—	0.691	—
Alpha-chlor 33	33.0	—	—	—	—	0.25	9.6
Chlorafin 40	40.0	—	—	—	—	0.16	—
SCL Concentrate	4.0	—	3.75	—	—	0.1882	—

Notes: *Product of Lubrizol Corporation.
‡Product of Enjay Company.
**Product of Monsanto Chemical Company.
SCL Concentrate also contains 37.5 per cent of saponifiable material and 5.7 per cent of a lead compond figured as lead oxide.

intended for heavy-duty, splash-lubricated gears of the worm type.

Film Strength Agents

Film-strength additives are often referred to as E.P. or extreme-pressure agents. The term film-strength may lead one to think that the fluid itself maintains a film that prevents metal to metal contact, but actually the coating that keeps the metal from scoring results from a reaction of the additive. The chemistry of the formation of anti-weld films will not be detailed, but mention will be made below of what specific additives are recommended and the proportions recommended.

Largest usage of E.P. additives is in gear lubricants for automotive vehicles. A lesser amount is used in lubricating greases and even in crankcase oils. Many E.P. additives are corrosive to metals, and those should be chosen that are not too corrosive and yet will form anti-welding compounds when in service.

Such additives are for the most part compounds containing chlorine, phosphorous, and sulfur. Certain zinc compounds, such as zinc dihexyl dithiophosphate, may be included. The first successful E.P. gear compound contained sulfur compounds and lead soaps, and such a product is still used for the initial fill by some automobile manufacturers.

Since the evaluation of E.P. gear compounds is costly and prolonged, most of this work has been undertaken by additive suppliers, which include some large oil companies. Since all oils are not equally receptive to a specific additive combination, tests are normally made in oils that are generally available to several suppliers. Much of this testing work is conducted at Armour Research Foundation, but some is also done at the Southwest Research Institute.

Mention of E.P. gear compounds will often include reference to MIL-L-2105, which is the specification under which the military forces procure their requirements. Before such purchases are made, the gear lubricant must have passed approval tests that are conducted at Armour Research Institute. After this, any material supplied must conform to additive limits as indicated by the approved sample.

Most additives that have been approved are furnished by the supplier in a liquid form that contains a certain proportion of mineral oil as a carrier. The characteristics of certain of these brand name additives are given in Table 7. Also included are some compounds from which additive mixtures might be made.

The compounds that have been proposed for use in compounding E.P. gear lubricants are very numerous, but those actually used are rather restricted.

Chlorinated paraffin wax has had considerable use in preparing E.P. gear additives. This is obtainable as a viscous fluid with varying proportions of chlorine, that normally used having 30 to 35 per cent of this element. Use of this material has the advantage of both cost and availability. For example, a chlorinated paraffin wax can be purchased for approximately 16 cents per pound. It is also compatible with most lubricating oils.

A great variety of other chlorinated compounds has also been proposed and tested for similar use. Hexachlorethane was widely used in gear oils in Germany during the last war. In a motor oil, methyl dichlorostearate has been used as a film-strength additive. According to Lincoln *et al*,[13] trichlororesorcinol gave the highest value on a Timken E.P. Tester of any material tested. "Alpha-Chlor 33" (Carlisle Chemical Works, Inc.), with a chlorine content of 33 per cent, when used in a concentration of 4 per cent in an SEA 90 Gear Lube Stock, was found to stand a 70 lb load on a Timken E.P. Tester, whereas a similar proportion of chlorinated paraffin wax, containing 42 per cent of chlorine, withstood only a 35-lb load. Chlorinated naphthalene, sold under the name of "Halowax," has been used in E.P. lubricants to some extent, but toxicity has led to discontinuing this use in most cases.

Organic phosphites, such as tributyl phosphite, and organic phosphates, such as tricresyl phosphate, have some value as E.P. lubricant additives. In fact, according to Smalheer and Mastin,[18] something over 500 U. S. patents having to do with the use of phosphorous compounds in lubricants were issued in the period 1912 to 1950.

Often the phosphorous will be a constituent of a compound that also contains either chlorine or sulfur. Thus products obtained by the action of phosphorous pentasulfide on organic compounds such as aliphatic alcohols lead to the formation of dithio-phosphoric acid diesters that may be included in additives.

A satisfactory sulfur compound for hypoid gear lubricants, in fact for most E.P. applications, should not be corrosive to copper or its alloys at temperatures below 300 F, yet above this point it should have an activity so that the sulfur will be broken off from the compound as needed. Also the compound should be soluble in lubricating oils, moderate in cost, and have a high proportion of sulfur if possible.

Dibenzyl disulfide has been found to satisfy all of the above requirements. Hence, this compound has had considerable use, often mixed with chlorinated paraffin wax, to give E.P. additives, which in turn have been used in compounding hypoid gear lubricants.

A variety of unsaturated organic compounds have been sulfurized to yield products that have been used as E.P. agents. Thus, olefins, fatty oils, and terpenes have been used as starting materials. Sulfurized sperm oil in particular has considerable use in cutting oils.

Dialkyl xanthyl ethers, in a proportion of 2 per cent in mineral oil, are said to have good E.P. properties. These compounds, like many other sulfur containing materials, have rather disagreeable odors, but gear cases are generally sufficiently tight that the car owner is unaware of the bad smell.

Many E.P. additive compounds are those containing two or more of the active elements. For example, the sulfur chloride reaction products of fatty materials such as fish oils, lard, sperm oil, etc. are often used as additives. Some compounds are more complicated as are the chlorobenzyl alkyl xanthates, which form the base of E.P. compounds marketed by one supplier.

Even three active elements may be included in the same chemical compounds, such as animal, marine, or vegetable fats, oils or waxes, can be treated with sulfur chloride and then with phosphorous pentasulfide to yield sulfo-chlorinated and phosphorized materials.

Any of the compounds mentioned that contain two or three active elements may also be blended with an E.P. compound containing only one active element.

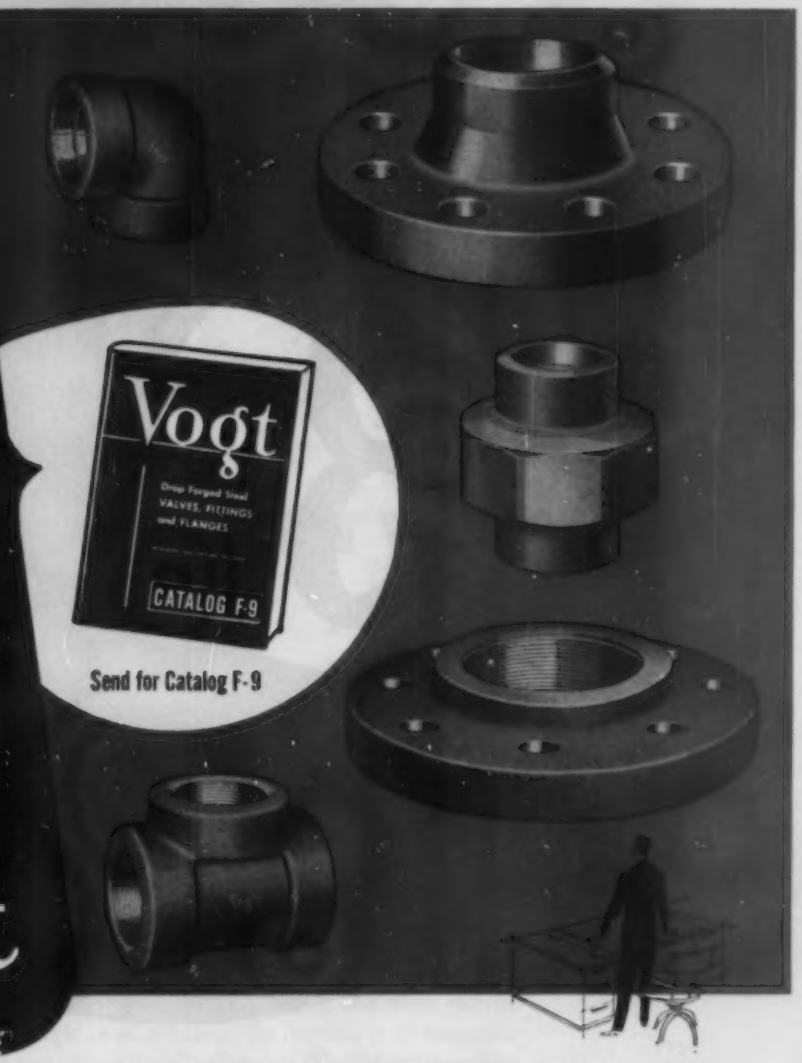
How to Choose An E. P. Additive

While a number of investigators have attempted to correlate chemical structure with test or service results for a number of suggested E.P. compounds, the final evaluation seems to be empirical. Suppliers of additives have a background of a great deal of bench and service testing and, hence, are in a much better position to make recommendations for specific applications than is one just starting to formulate an E.P. lubricant.

Further, the demands upon such lubricants are not always fixed. This is illustrated by the present situation with regard to E.P. Gear Lubricants for automobiles and trucks. The increasing horsepower and speed of engines together with the torque requirements of trucks make it appear that there will be a change in the load requirements of E.P. compositions. Where the final product is for indus-

STRONGER and SAFER for every high pressure pipeline duty...

...because they are **drop forged** *by* **Vogt**



Send for Catalog F-9

Constantly imitated but never duplicated, Vogt drop forged steel fittings and flanges have unmatched strength and toughness for your most severe pipeline duties. Laboratory controlled materials and Vogt's special forging techniques assure products which are always uniform in structure, fine grained, and free from porosity. Thereby the shocks and stresses imposed by high pressures and high temperatures are easily withstood, and with stubborn resistance to erosion and corrosion. Consult Catalog F-9 for our complete line of fittings and flanges.

For a copy of Vogt Catalog F-9 address Dept. 24-FPE.

HENRY VOGT MACHINE CO., P.O. BOX 1918, LOUISVILLE 1, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati, San Francisco

OTHER VOGT PRODUCTS

Drop Forged Steel Valves — Petroleum Refinery and Chemical Plant Equipment — Steam Generators — Heat Exchangers — Ice Making and Refrigerating Equipment.

Vogt

DROP FORGED STEEL

Fittings and Flanges

Every refiner is facing a constantly increasing demand for higher octane gasolines. Whether or not he makes money may well depend on his being able to provide these efficiently and economically. For today's and tomorrow's requirements one high octane stream just isn't adequate to provide the essential quality in pool gasoline. The most practical way this can be done is through an improvement of the poorer quality blending components that presently drag down pool gasoline octanes.

This is why much of UOP's research has been constantly directed toward the improvement of the poorer components that reduce pool gasoline quality. This has resulted in the recent development of PENEX, UOP's newest refinery process. Through isomerization, PENEX provides a means of up-grading pentane and hexane fractions, the previously neglected components that definitely lower pool gasoline octanes.

This is a mighty poor spot for a refinery...

The future success of your business will depend on getting the most out of every drop of oil that passes through your refinery. To do this it is essential that your planning be geared to the necessity of achieving the highest possible octanes in your pool gasoline. Find out now how the PENEX process will help you accomplish this, and make it part of your planning for a continuing successful operation.

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U. S. A.
Forty Years of Leadership in Petroleum Refining Technology

PENEX
TRADEMARK

A new isomerization process for up-grading pentane and hexane fractions

trial use, there may be less change in requirements.

It would seem wise to purchase either the individual E.P. compounds or perhaps the blended additives. For example, only in the case of large consumption is it advisable to try to sulfurize fats or fatty oils since there is not only a know-how but also an odor nuisance to contend with.

Antiwear Agents

According to some investigators, wear prevention agents and E.P. agents can be distinguished from each other. The former are effective by a chemical polishing action, which may take place at a lower temperature than does the formation of antiweld film where E.P. lubricants are required.

Tricresyl phosphate, at a concentration of 1.5 per cent is an effective antiwear agent. Also 1.5 per cent of triphenyl phosphite and 1 per cent of a natural fat in a lubricating oil will serve for the same purpose.

Antifoam Agents

Some lubricating oils, containing additives, for example crankcase and gear lubricants, tend to form a tight foam during circulation or by the action of the gear teeth, which pull air into the fluid. To accelerate the breaking of such foams, very small proportions of additives are used. Silicone fluids, in concentration of 0.01 to 0.001 per cent or even less, have been the most widely used antifoam agents.

Since the above compounds are not soluble in mineral oils, there have been some reports of their becoming inactive as antifoam agents after the lubricant is stored. Therefore, other additives have been suggested for the purpose. For example, 0.1 per cent of "Aerosol OT" is thought to be effective.

It will be found that most suppliers of additive compositions for either crankcase oils, diesel oils, or E.P. gear compounds include antifoam agents in their products.

Emulsifiers

With most lubricants, emulsification is not desirable, but in some products, primarily soluble oils, emulsifiers are purposely added. These soluble oils are mixed with water to form a coolant and lubricant while cutting, drilling, or grinding metals.

The most common emulsifiers are sodium or potassium soaps of fats or fatty acids, sulfonic acids, or naphthenic acids. The reaction products of triethanolamine with fatty acids, such as oleic, have also been used as emulsifiers. Another class of materials recommended for this purpose are "Spams" and "Tweens," distributed by Atlas Powder Company.

Water Repellants

Water repellancy is particularly necessary in the case of certain nonsoap thickeners used in the production of lubricating greases. For example, silica gels are used for bodying oils, but the silica is very susceptible to the action of water. As a consequence, certain hydrophobic (water-hating) cationic surface-active compounds are added to the system.

Organosilicon polymers, in a proportion of at least 10 per cent of the silica, are satisfactory waterproofing agents. Certain higher aliphatic amines, hydroxy fatty acids, or polymerization products of butadiene or styrene are also effective coatings.

Clay-type thickeners for lubricating fluids also require water-repellant attachments, which may consist of various surface-active agents.

More details of the above type of additive will be found in Boner,[4] p 704-707 and 749-750.

Stringiness Additives

Where it is desirable to increase the adhesiveness of lubricating oils or greases, certain polymers, such as "Paratac" (Enjay Company), are added. As little as 0.01 per cent of this material is noticeable. Solutions of crepe rubber in mineral oil have also been used but lose their effectiveness upon storage.

Another method of arriving at stringiness characteristics in lubricants is to disperse certain aluminum soaps, particularly those of unsaturated fatty acids, in lubricating oil.

Dyes

If a distinctive color is desired in a lubricating oil or a lubricating grease, oil-soluble colors can be used. The same colors as are employed in certain gasolines might also serve. Manufacturers of dyes, such as Calco, DuPont, or National Aniline, should be able to supply the colors desired.

Green or red fluorescent dyes are sometimes added to lubricating oils to give them an attractive cast.

Odor-Control Agents

While the practice is not general, some lubricating greases do have additives used to give distinctive odors. A number of years ago, nitro benzol was frequently used for this purpose. Pine tar also has some application. Manufacturers of synthetic perfume materials will recommend moderate-priced blends, which can be used as odors.

Perhaps the most disagreeable smell in lubricants arises from sulfur compounds used as E.P. agents, and there has been no apparent attempt to cover up such odors.

Structure Modifiers for Soap-Oil Systems

While most lubricating greases consist primarily of lubricating fluids thickened with various dispersed soaps, minor amounts of other compounds are also present and are, in the main, necessary. These additives are covered by the general term structure modifiers. A great variety of compounds are used for the purpose of stabilizing the structure of lubricating greases, and a few of these will be mentioned. For those desiring to pursue this subject in greater detail, Boner,[4] p. 37 to 54 gives a detailed coverage.

Probably the first such additive and the one most widely used for many years was water. This is still the agent that stabilizes the structure of most calcium soap-oil systems. Some higher alcohols, such as glycerol, or the alcohols derived from sperm oil or wool fat serve a similar purpose. Likewise, glycols, such as ethylene glycol or propylene glycol, have been used as additives in lubricating greases.

Free fatty acids and also mono glycerides of various fatty acids are used as additives for soap-thickened oils. Various metal salts of low molecular-weight acids are likewise used as structure modifiers. The most widely used are barium and calcium acetates or carbonates.

The above additives may often be formed *in situ* rather than being added in a preformed state.

References

1. Atkins, D. C., Jr., Baker, H. R., Murphy, C. M., and Zisman, W. A., *Ind. Eng. Chem.*, 39, 491-497 (1947).
2. Beard, L. C. Jr., *ASTM Bulletin*, 198, May, 1954, p. 51-6.
3. Bondi, A., *Physical Chemistry of Lubricating Oils*, Reinhold Publishing Corporation, New York City, 1951.
4. Boner, C. J., *Manufacture and Application of Lubricating Greases*, Reinhold Publishing Corporation, 1954.
5. Calhoun, S. Fred, "Antioxidants for Greases" NLGI Annual Meeting November 1, 1955, to be published in *NLGI Spokesman*.
6. Fraser, Harold M. and Maxwell, T. A., U. S. Patent 2,361,391, October 13, 1944.
7. Georgi, Carl W., *Motor Oils and Engine Lubrication*, Reinhold Publishing Corporation, New York City, 1950.
8. Hamer, J. P., Tutwiler, T. S. and Weisel, C. A., *ASTM Bulletin*, 198, May, 1954, p. 70-77.
9. Harle, Oliver L., U. S. Patents 2,721,177-178, October 18, 1955.
10. Larsen, R. G., Thorpe, R. E. and Armfield, F. A., *Ind. Eng. Chem.*, 34, 183-93 (1942).
11. Larsen, R. G., and Diamond, H., *Lubricating Eng.*, 7,272-6 (1951).
12. Larson, C. M., *The Petroleum Engineer*, 27, 0-44-55 (1955).
13. Lincoln, Bert H., Byrkit, Gordan D., and Steiner, Waldo L., *Ind., Eng. Chem.*, 28, 1191-97 (1936).
14. MacDonald, R. T. and Dreher, J. L., *Inst. Spokesman*, 17, No. 1 (1953).
15. Murphy, C. M., Ravner, Harold and Smith, Nathan L., *Ind. Eng. Chem.*, 42, 2479-89 (1950).
16. Prutton, C. F., *The Institute Spokesman*, 5, No. 9, December, 1941, 5-8.
17. Roberts, E. N., U. S. Patent 2,409,799, October 22, 1946.
18. Smalheer, C. V. and Mastin, T. W., *Petroleum Processing*, 7, 1780-84 (1952).
19. Webber, M. W., *Petroleum* (London), 8, 76 (1945).
20. Zuidema, H. H., *Performance of Lubricating Oils*, Reinhold Publishing Corporation, New York City, 1952.

★ ★ ★

FIG. 1. & 2. To heat treat the "jigsaw innards" and the "chrome steel porcupine" of the new Houdriflow cat crackers at Sun Oil's Toledo, Ohio, and Marcus Hook, Pennsylvania refineries, 20 tons of gas-fired heater and 100 hp of blowers were hoisted 164 ft in the air, with special temporary fittings. A 30-hour cycle at 1250 F was used.

P 731.

Furnace-In-Sky

Sets Pattern For Vessel Stress Relief

Economics and technology of on-the-job heat treating makes interesting and useful results

P. C. Arnold

STRESS-relieving of large welded structures after final installation—even if they are 25 ft across by 71 ft tall and located 200 ft above the ground, inside a maze of structural steel, already surrounded by other equipment, or in place between preceding and succeeding units in the process sequence — is becoming quite a factor in both the engineering and the economics of big-scale fabrication.

Chicago Bridge & Iron has perfected the technique. CB&I finds it greatly helpful in building petroleum, petrochemical and chemical processing vessels.

Out of such experience in field stress-relieving, which already ranges from cat crackers to coke drums to digesters, come important clues to procedure and special equipment required.

Largest recent job typifying the method was the 30-hr stress relief of the 71-ft reactor portions of the two new Houdriflow units installed in 1955 by Sun Oil Company at Marcus Hook, Pennsylvania, and Toledo, Ohio, to increase that firm's throughput by 40,000 bbl of fresh distillate and 16,000 bbl of recycled fuels per day. To do the job, approximately 20 tons of temporary heating equipment capable of liberating 24,000,000 Btu per hour of heat was located 164 ft above ground level and the entire reactor vessel (25 ft by 71 ft) converted into a giant

"furnace-in-the-sky," complete with insulation, precise control of hot gas circulation, and remarkable temperature regulation.

It is estimated that each of the reactor sections to be stress-relieved high in location weighed approximately 250 tons — far too heavy to be fabricated as a unit on the ground. Each carried a maze of piping, baffles, fittings, internal heads, and special structures within its shell of chrome-moly steel, clad with 410-stainless. Wall thickness varied downward from 2½ in. to ⅝ in. several different steels of chromium content up to the brittle and air hardening 6 per cent specification were involved, and 10 types of electrodes were used in the welding. There were scores of openings in the vessel, more than a dozen being of 6-in. diameter or greater. The top nozzle was 42 in. in diameter and the main side manhole measured 58 in. in diameter.

Truly, here was a vessel necessitating stress relief in final erected position, for: (1) The unit was too massive to have been made and heat-treated on the ground as a unit, (2) the thousands of feet of weld had to be heat-treated with the body because service temperatures would be high (external insulation rather than internal), and (3) the economics of the case indicated making a furnace of the structure itself rather than building one to enclose it.

To set up for the job, CB&I laid a temporary steel bulkhead inside the reactor at the lower limit of the zone to be heat-treated, thereby creating a closed chamber that could be fired with hot air through a manhole and vented through the top and selected side openings (each fitted with a temporary butterfly damper) and bottom openings through bulkheads. The side of the shell and the top head were insulated with temporary layers of magnesia and mineral wool block to an average thickness of about 4 in., covering all of the openings, nozzles and fittings of the porcupined vessel except those few selected for vents and flues. Mineral wool insulation was laid on the temporary internal bulkhead at the bottom.

Heat input was provided by a special box-type furnace or heater with several 6,000,000 Btu-per-hour burners, plus a 50,000 cfm blower (requiring a 100-hp motor) to pump the hot gases at 1400 F from the box furnace through the manhole into the reactor shell. The heater itself measured 9 ft by 10 ft by 24 ft. All this equipment was mounted at the 164-ft level on the stair tower of the cat cracker, it being necessary to reinforce the stair tower temporarily to support the 20 tons of firing equipment. Two-inch piping carried refinery gas at 30 psi up the stair tower to a regulator from which it was distributed through 8-in. lines to the burners of the box furnace. The blower delivered hot air and combustion products at about 1 oz of pressure.

Since the heating cycle was 30 hr, (12 hr to heat up, 4 hr to hold at a work temperature of approximately 1200 F, and 14 hr of controlled cooling) and the vessel so internally intricate, some 30 thermocouples were distributed over and within the shell at critical points to check temperature uniformity.

It was necessary to use a baffle plate inside the vessel to direct the hot gases through the disengager head to the very bottom of the section being treated.

The Author

P. C. Arnold is a field welding engineer for Chicago Bridge & Iron Company. He worked for the company intermittently from 1927 until 1938, when he received his BS in civil engineering from Kansas State College of Agriculture and Applied Sciences. Since 1938, he has been with the company continuously. He has worked in the erection department and at the company's Seneca, Illinois, shipyard during World War II. Since 1945, Arnold has been a field welding engineer in the general erection department of the company with headquarters in Chicago, Illinois.

These baffles and the bottom bulkhead were, of course, cut up and removed from the unit after the heat treatment. Otherwise, heat distribution was manipulated by adjusting the butterfly dampers on the selected side and top vent openings through the insulation.

Because of these advance provisions for heat distribution (a subtle part of the technique) less than 90 F temperature variation between any two points in the huge and complicated structure was noted at the beginning of the 4-hr holding cycle. The ASME code for unfired pressure vessels permits 150 F variation. At the end of the holding cycle, the maximum variation was less than 40 F.

The exacting demands of this accomplishment — using the structure itself as the furnace shell and with the heat-equalizing advantages of hot gas recirculation, and on such a Herculean scale so high above ground — will be apparent to anyone familiar with heat treatment.

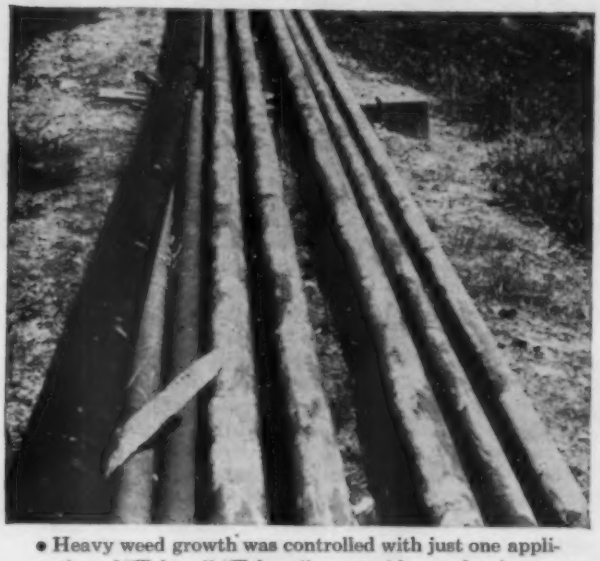
Not a small detail to remember in the heat treatment of such large structures after erection is the effect of thermal expansion. In this case, the structure being 71 ft tall, total vertical expansion at heat-treating temperatures calculated out to about 9 in. It was necessary to anticipate it. Accordingly, CB&I provided slip joints with play in the connection between the hot-gas blower and the manhole entrance to the reactor.

Such stress-relieving of complicated and large structures after final placement in the midst of other construction is not for the amateur. CB&I's engineers have perfected the technique over several years and many experiences, and have developed an inventory of box-heaters, luminous burners and blowers (up to the large sizes used on the Sun Oil Houdriflow units) that make the technique practicable. The economics of the temporary furnace, be it of the conventional type on the ground or a sky-high unit using the very structure to be heat-treated at the shell, depend upon the salvage and re-use value of the materials and equipment involved, as well as upon the know-how of heat loss and heat distribution. Indeed, were there is a choice, shop heat-treatment is generally to be preferred. ★ ★ ★

"Does Mum come in gallon sizes?
I've been cleaning a cat-cracker."

Save Money, Labor on Weed Control!

• Around tanks, refineries, wells and pipelines, "Telvar" gives long-term weed control . . . reduces fire hazards.



• Heavy weed growth was controlled with just one application of "Telvar." "Telvar," a wettable powder, is non-corrosive, non-flammable, non-volatile, low in toxicity to humans, livestock.

One spray of **Du Pont** **TELVAR®** WEED KILLER kills weeds for a season or longer

When you use "Telvar," vegetation is killed through the roots, and regrowth is prevented because the chemical remains in the soil . . . provides residual action all season long. And low dosages (1 to 1½ lbs. per 1,000 sq. ft.) make it cost little for the results you obtain. Such low rates also mean less handling, less use of storage facilities.

Include "Telvar" in your weed-control program this year. Prove to yourself how this product of Du Pont research can help cut your maintenance cost to new low levels. "Telvar" weed killer for industry is available in two formulations: "Telvar" W and "Telvar" DW.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

TELVAR®
WEED KILLER

On all chemicals always follow directions for application. Where warning or caution statements on use of the product are given, read them carefully.

SEND FOR FREE ILLUSTRATED BOOKLET DESCRIBED BELOW

E. I. du Pont de Nemours & Co. (Inc.)
Grasselli Chemicals Department
Room D-4030
Wilmington 98, Del.

☐ Please send me your booklet showing the results of "Telvar."

☐ Send me the name of the nearest supplier.

☐ Give me the name of a nearby custom sprayer who will apply "Telvar" for me.

Name_____

Firm_____

Position_____

Address_____

City_____ Zone____ State_____

II. SELECTING EQUIPMENT

B. Mechanical Design of Process Tubular Heaters

Section 4

L. A. Mekler
Consulting Engineer

NATURAL draft air is controlled either by stack dampers or dampers at the burner assembly. Each has advantages and disadvantages. The block in a burner assembly is an integral part, must be designed to fit burner and fuel. Two main gas burner types are premixing and nozzle-mixing. Oil burners are either mechanically atomizing, seldom used on process heaters, or impact atomizing. High turbulence of fuel-air mixtures is necessary for efficient combustion.

Air Supply

With natural draft, the supply of total air to the burners is controlled in two ways: Locally, by registers or louvers on the individual burners, and by master control through a damper in the stack or a damper on the inlet of a plenum chamber around the burners. A stack damper is the oldest means for controlling the supply of total air by natural draft and is the most common arrangement, particularly for heater with horizontal tubes.

One of the main advantages of a stack damper is its lower cost and simpler linkage for manipulation than a damper on the plenum chamber. Another advantage of a stack damper, important only with heaters designed without particular care as to tightness of the setting, header boxes, peep holes and other openings, is that closing the damper to reduce the supply of total air also reduces the draft level throughout the heater and thus decreases the air infiltration into the heater. With a damper in the plenum chamber, closing the damper will increase the draft level and air infiltration. Also with a loosely fitting damper in the stack and on a plenum chamber, so that neither can be shut tight, less air will be admitted to the "unfriendly fuel" from a tube rupture with a stack damper than with a damper on the plenum chamber.

On the other hand, a stack damper has a number of disadvantages. Closing the damper too much to obtain the desired draft at the burners may put the top of the heater under pressure and force the gases through the setting, peep holes, and header compartments. The escaping gases may scorch paint around the openings, warp doors and peep hole covers, etc. With some types of suspended-roof construction, a pressure under the roof may cause large leaks through the roof, which may overheat the roof beams sufficiently to cause the roof to sag until the accumulative effects of increasing leaks due to sagging will require major repairs.

In vertical tube up-fired heaters, there may be a draft difference of 0.2-0.8 in. W.G. between the top and the bottom of the heater. In these heaters, even a small reduction of draft at the burners by closing the stack damper may produce a pressure at the top. In heaters J and K, with unlined stacks, air is drawn in at the base of the breeching to cool the breeching and the bottom of the stack. A pressure or a very low draft at the top of the heater caused by closing the stack damper may cut off the draft on the cooling air vents and cause overheating and buckling of the breeching and the bottom of the stack.

Most serious objection to a stack damper is that, if closing the damper does not fully shut off the air in case of a tube rupture, the flames from the "unfriendly fuel" will be forced through the burner openings, peep-holes, etc., which may cut off access to the valves of locally controlled snuffing and drop out lines and, in the worst case, start a fire in the adjoining equipment.

Control of total air by a damper on the plenum chamber also has its advantages and disadvantages, which are the opposites of those of the stack damper. The most important advantages of a damper on the plenum chamber are that with it, all portions of the heater are under draft conditions, which eliminates the troubles due to hot gases escaping from the zones of pressure, and that the stack is unobstructed, which permits free escape of the flames from a tube rupture into the atmosphere at the top of the stack, and reduces the danger of the tube-rupture flames interfering with local safety devices or causing a fire in the process area.*

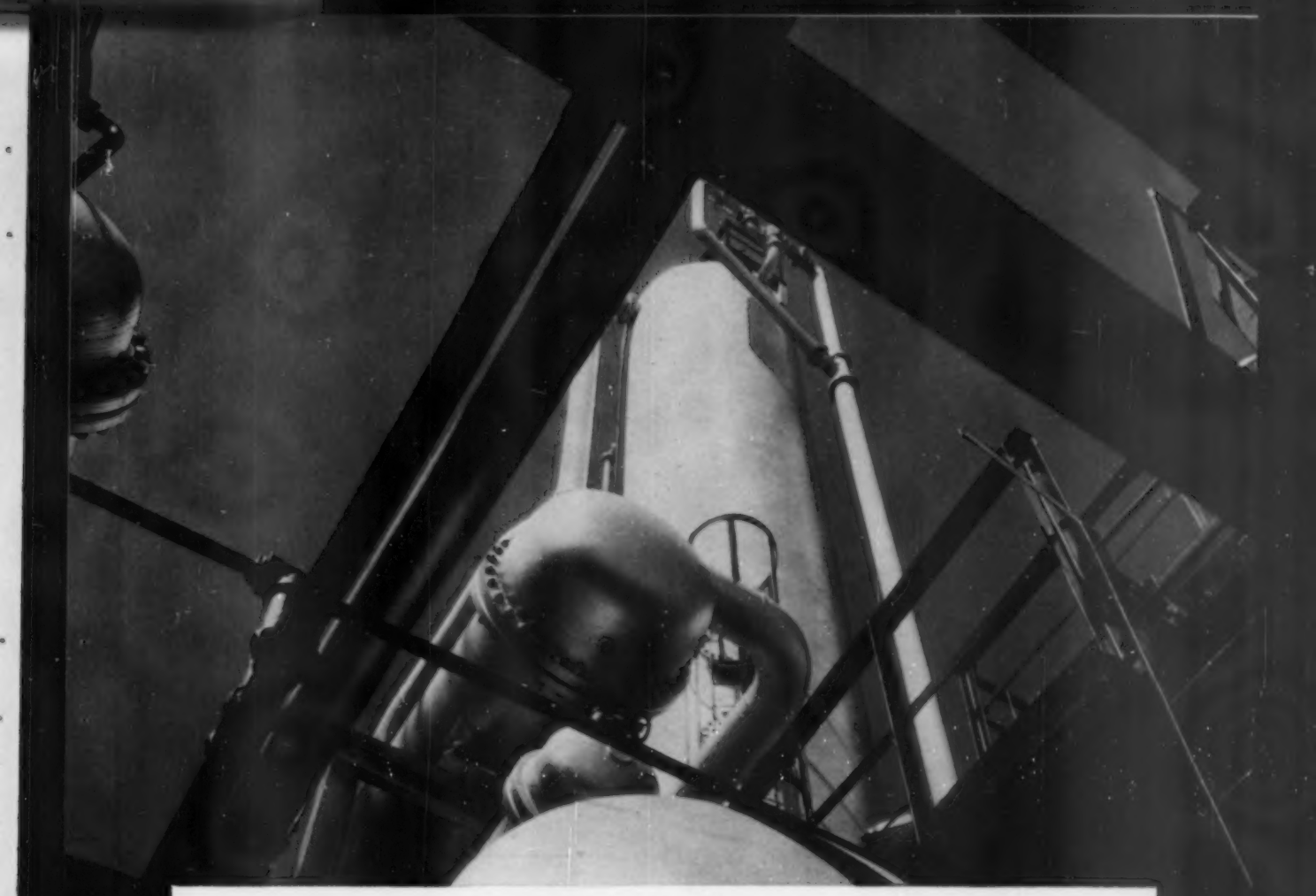
In localities with strong variable winds, control of total air by a damper on the plenum chamber has an additional advantage in that it provides the heater with a wind breaker. With a stack damper control, a separate wind breaker may have to be installed on the heater to minimize the effects of variable winds on burner operation.

Generally, master dampers are of the multiblade-louver construction. A single-blade butterfly damper gives poor control between closed and one-third open position and between two-thirds and fully open position.

Forced draft is used mainly on heaters with an air preheater, usually in conjunction with an induced-draft fan. Recently, a few process heaters were built for operation with the combustion chamber under pressure to assure a specific path of gases through the heater. In these heaters, forced draft fans are used without an air preheater, or as the only fan with an air preheater.

*With either type of damper the most positive way of preventing damage by fire from a ruptured tube inside or outside of the heater is an ample supply of remotely controlled snuffing steam into the combustion chamber and header boxes of the heater through lines big enough to fill the chambers and the header boxes in less than 10 sec and replenish the steam as fast as the draft pulls it out.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE



PROTECTED *with* KONTOL

Kontol effectively protects a wide variety of refinery equipment. In a typical depropanizer application in an eastern refinery, Kontol's detergent action permitted the running time to be doubled. After eight months of Kontol usage, corrosion in overhead condenser was not measurable, heat transfer coefficient was increased by 33⅓% and tower tray corrosion was eliminated. Get similar benefits for your refinery. Your Kontol service engineer will gladly show you how and where.

KONTOL CORROSION PREVENTIVES ARE EFFECTIVE IN

Crude Stills • Depropanizers • Debutanizers • Depentanizers • Absorbers • Stabilizers Platformers • Reformers • Vacuum Towers • Alkylation Plants • Coking Systems • Dewaxing Systems • Gas Recovery Systems • Cat Cracker Fractionators Alkanolamine Sweeteners Desulfurization Systems

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, Saint Louis, Missouri • 5515 Telegraph Road, Los Angeles 22, Calif.

PETROLITE LIMITED, 120 MOORGATE, LONDON EC2, ENGLAND

KR-566

Monel Bubble Cups and Tray for top of new fractionating tower completely engineered and fabricated by Fritz W. Glitsch and Sons, Inc., Dallas, Texas. Notice Monel weirs and baffles.

Here's where Monel proves year-after-year resistance to common tower-top corrosives

Tower-top corrosion *can* be held within practical limits.

Monel* nickel-copper alloy bubble caps proved *that* long ago. Their record . . . at temperatures up to 500°F. . . shows outstanding resistance to the aqueous hydrochloric and sulphuric acids and the corrosive salts commonly present in this critical upper section.

Today, for towers handling corrosive streams, Monel alloy is preferred in this location.

The men with the sharp pencils say Monel alloy costs less per pound than other commercially available alloys able to withstand the corrosion in tower tops.

Fabricators such as Fritz W. Glitsch & Sons, Inc., find it is easy to form . . . lends itself well to lined or clad construction. Increasingly, they find it specified not only for caps and trays but also for distribution pipes, fittings, linings, the shell itself and overhead condensers.

Another advantage. Monel equipment can be field erected and easily field repaired. No heat treatment after welding is required to maintain corrosion resistance.

How is your tower down-time record? If it's not what it should be and corrosion is the cause, look into the possibilities of Monel alloy construction. Simply write Inco's Corrosion Engineering Section. *Registered Trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys Perform Better Longer**

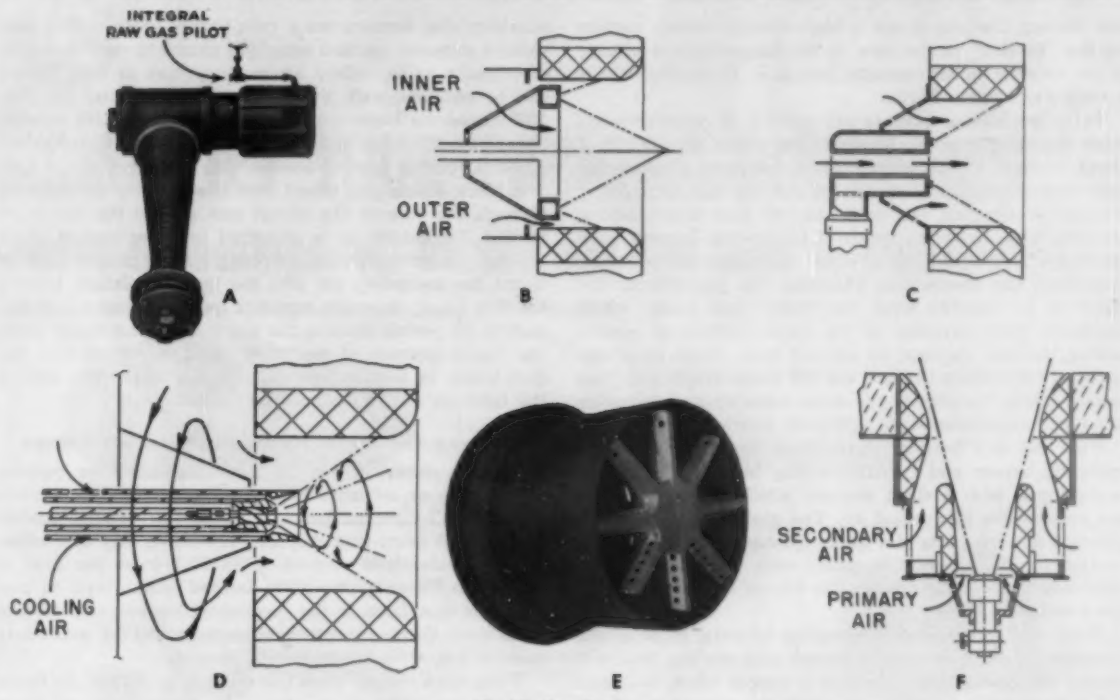


Fig. 13. Gas Burners.
Fig. 13A and 13F Courtesy National Airoil Burner Company Fig. 13E Courtesy John Zink

Burners

Most important part of fuel-burning equipment is the burner proper, or the "gun," and the refractory block, or the "burner throat," used with the burner. Until recently, the burner block was considered only as an opening in the setting to admit fuel and air into the combustion chamber. In the last few years, burner manufacturers and heater designers began to realize that the block is an important integral component of the complete burner, and that with an improperly designed block, a good burner will operate less satisfactorily than a mediocre burner with a block with a contour coordinated with the shape of the stream from the burner gun, the direction of firing, and geometry of the heater.

Principal function of the burner block is to provide a zone of incandescent refractories near the root of the flame to maintain ignition and to create the proper eddies near the entrance and the outlet of the block. The incandescence is obtained when the periphery of the stream from the burner just glances over the refractories somewhere midway between the ignition point and the outlet from the block. If the stream impinges on the block, coke will form at the point of impact, particularly with liquid fuels. If the stream completely misses the refractories, there will be no incandescence. The shape of the block must also be such that the fuel-air mixture on ignition produces outward and backward eddies near the inlet of the block to stabilize the flame, and forward and inward eddies near the outlet of the block to bring hot products of combustion from the periphery of the flame into the central core. The eddies are particularly helpful with liquid fuels. With a burner and block designed as an integral unit, liquid fuels, including the pitch-like residues, can be burned with clean, smokeless flames with less than 20 per cent excess air and gaseous fuels with less than 10 per cent excess.

As yet, there is no *single* burner that can burn successfully gaseous and liquid fuel alternately or simultaneously. The so-called "combination" burners consist of two separate burners, one for gas and one for oil, arranged to fire through the same burner flock. Generally, in some combination burners, the emphasis is on gas firing while in others the design favors liquid fuels. One superintendent of a plant with a large variety of combination burners on different heaters classified the burners as either a gas burner with an oil burner appendix, or an oil burner with a gas burner appendix.

Gas Burners

There are two main types of gas burners, air-inspirating "premixing" burners and "raw gas," or nozzle-mixing burners. In the inspirating burners, the total gas is discharged in a single stream into a mixing tube where the gas and the air injected by the gas stream are mixed before they leave the burner ports. With a theoretical venturi mixing tube, the gas jet can inject more than the theoretical air required for combustion. Some commercial premixing burners with a long venturi mixing tube, often called "fully inspirating" burners, induce and premix 80-90 per cent of the theoretical air and require only 20-30 per cent of the theoretical as secondary air. The majority of premixing burners have a short mixing tube of venturi-like contour that induces and premixes 30-50 per cent of the theoretical air and requires 70-90 per cent of the theoretical as secondary. Fig 13A shows a long-venturi, fully inspirating burner, used on heaters J and K.

In nozzle-mixing burners, the gas is discharged through a number of relatively small jets into the burner block. Generally, the individual jets are arranged to produce a turbulence within the block by impingement upon each other or by imparting a screw rotary motion to the gas. In the ring-type nozzle mixing burner in Fig. 13B, most of the jets are tilted inward to intersect along the centerline of the ring. A few jets are tilted outward to impart a glancing blow upon the surface of the block to make it incandescent. Fig. 13C shows a barrel-type nozzle mixing burner that is similar in principle to the ring burner, except that all the jets are turned outwards. Fig. 13D is a nozzle-mixing burner developed and used extensively abroad. In

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

this burner, the gas, given a high-velocity rotary motion by the "twirler" at the end, is discharged into a stream of air rotating in an opposite direction. Primarily, this is a very short flame burner.

Fully inspirating burners are gaining in popularity on most types of process heaters. The main advantage of these burners is that they can be operated consistently with lower amounts of excess air and are less affected by changes in direction and wind velocity than nozzle-mixing burners. Also, since the spuds of inspirating burners have relatively large openings and are not subjected to radiation from the combustion chamber, the burners do not have to be cleaned with high-sulfur fuel gases, which normally form deposits in the small orifices of nozzle-mixing burners exposed to radiant heat. Main disadvantages of inspirating burners are the much larger size than nozzle-mixing burners of the same capacity and the noise level when operated with high-spud pressures.

Fig. 13E is a burner intermediate between a fully inspirating burner and a nozzle-mixing burner. The burner is equipped with a short venturi, which inspirates 30-40 per cent to the theoretical air. The gas-air mixture is discharged through ports of a spider arranged to give a rotary motion to the gas as it is mixed with the secondary air admitted between the spiders. No burner block is normally used with this burner.

With the long-venturi inspirating burners, most of the combustion air is intimately mixed with the gas before it enters the burner block so that a simple block that provides incandescent refractories near the root of the flame is all that is required.

With partially inspirating, short-venturi burners, more than half of the total air is secondary air. Therefore, the burner block must have a contour that will induce turbulence required to mix relatively large amounts of air with the ignited fuel-air mixture, create the eddies to stabilize the flame, and recirculate hot gases into the core of the ignited mixture to the extent required for the desired length and character of the flame. With nozzle-mixing burners, the mixing of gas and air produced by the correllated contours of the gas stream and the burner block is usually augmented by a directional-louver air register, which gives a rotary motion to the air in the block. Some nozzle-mixing burners use a twin-burner block, which provides a separate ignition zone and means to vary the ratio of primary to secondary air so that short or long flames can be obtained with the same amount of total air. Fig. 13F shows the barrel—nozzle mixing burner with a twin-burner block, which is a standard arrangement on heaters J and K for this type of burner. The first block is the ignition block where gas, mixed with the primary air entering through the core of the barrel and around the nozzle, is ignited. Secondary air is admitted into the second block around the primary block through an annulus shaped to direct the secondary air into the ignited mixture leaving the first block. Separate registers on the primary and secondary air permit burning the gas with a short flame when the major portion of the total air is admitted into the first block, or with a long flame when more than half of the total air is admitted to the second block.

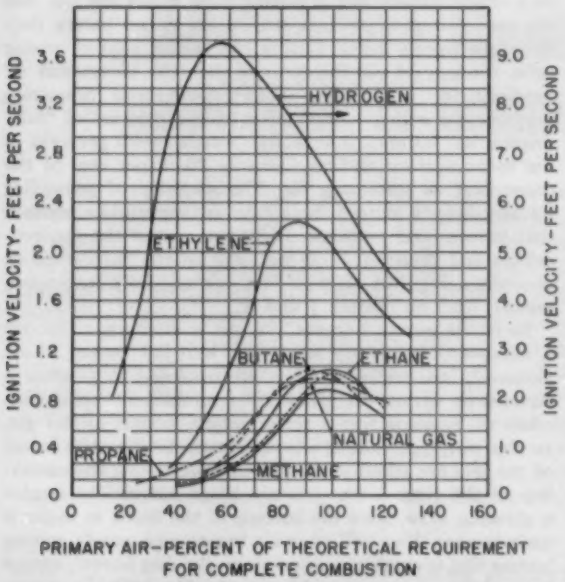


Fig. 14. Velocity of Flame Propagation of Hydrocarbon Fuel Gases and Hydrogen.

Burners for High Hydrogen Content Gases

Burners shown in Fig. 13 were developed for burning natural gas or mixtures of natural gas with hydrocarbon tail gases. In recent years, a number of plants started burning tail gases from naphtha reforming and aromatization processes that contain up to 90-volume per cent of hydrogen. These gases, when burned alone, tend to preignite or flash-back in the inspirating burners and to produce hazy flames, sometimes accompanied by secondary combustion, with nozzle-mixing burners.

Flash-back occurs when the mixture is within the limits of inflammability of the gas and the velocity of flame propogation is higher than the velocity of the gas-air mixture before ignition. Hazy flames are produced when ignition is not turbulent enough to intimately mix the total air with the ignited fuel. Table 5 and Fig. 14 show the differences in combustion characteristics of hydrogen and the three principal hydrocarbon fuel gases, which account for much of the difficulties with burning high-hydrogen gases in conventional burners.

From Fig. 14, the maximum flame-propagation velocity of the hydrocarbon gases obtained in a particular small-diameter tube is in the neighborhood of 3 fps and occurs with mixture close to the theoretical. The maximum flame-propagation velocity of hydrogen in the same tube is approximately 10.5 fps and occurs in a mixture with about 50 per cent of the theoretical air. According to the limits in inflamability in Table 5, hydrocarbon gases will not ignite in mixtures with less than 40 per cent theoretical air while hydrogen ignites with as little as 15 per cent. Therefore, hydrocarbon gases can be burned without flash-back in partially inspirating burners with almost any velocity through the mixing tube in mixtures containing less than 40 per cent of the theoretical air, and at relatively low velocities in mixtures with higher air content. Hydrogen-rich fuels will flash back in almost any mixture with air below 50 per cent, unless the velocity of the mixture through a given mixing tube is three to four times the velocity of the hydrocarbon gas-air mixture. In fully inspirating burners, the high-hydrogen gases require at least twice the mixture velocity satisfactory for hydrocarbon gases.

As shown in Table 5, a pound of hydrogen requires over 33 lb of theoretical air. The higher velocities and induction ratios required with hydrogen must be obtained with a gas with a specific gravity of only one-tenth of the gravity of hydrocarbon gases, so that with high-hydrogen gases the pressure on the spud must be considerably higher than with hydrocarbon gases to induce the same proportion of theoretical air. Normally, with a fully inspirating burner, the spud pressure with hydrogen-rich gases is 30-50 psi as against a 10-15 psi used with hydrocarbon gases.

Hazy flames obtained with high-hydrogen gases in noz-

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

US RUBBER PACKINGS

SIMPLIFY YOUR PACKING PROBLEMS

these 6 packings will handle most of your requirements

STYLE 193

STYLE 193—U. S. CENTRIFUGAL PUMP PACKING

For centrifugal pumps, or other rotating or oscillating rods or shafts, handling hot or cold, fresh or salt water, oil, brine, weak acids, caustic solutions and ammonia. Made of long fibre asbestos yarn, plaited square. Each strand thoroughly lubricated and graphited.

STYLE 101—U. S. RAINBESTOS HIGH-PRESSURE ROD AND PLUNGER PACKING

Designed for high-pressure steam, air and gas up to 500° F. Made from selected asbestos cloth, woven from tightly twisted asbestos yarn, with a genuine U. S. Rainbow non-hardening cushion, formed square, and treated with heat-resisting lubricants and preservatives and with a graphite solution.

STYLE 101

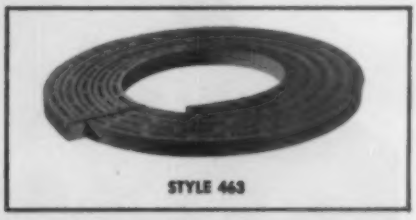
STYLE 16010—DUCK AND RUBBER

STYLE 16010—U. S. MATCHLESS PACKING

Matchless is the high-pressure packing—will withstand hydraulic pressures as high as 8000 pounds. Self-adjusting, automatic action results in reduced wear and tear on rods and plungers, minimizes friction, keeps down packing costs. For hydraulic equipment, presses, rams, triplex pumps, outside packed pumps, and swivels on rotary drilling rigs.

STYLE 463—U. S. PEERLESS CANVAS PUMP PACKING

For service on inside packed pumps against hot or cold water, and for end rings in hydraulic sets. Made from first quality, closely woven duck laminations cemented together with a high quality rubber friction. Light in weight.



STYLE 463

STYLE 125

STYLE 125—U. S. WIZARD ROUND BRAIDED ASBESTOS PACKING

For use in valve stems, reciprocating rods and plungers, against steam, air, hot and cold water, ammonia, oil, chemicals and some acids. Made of long fibre asbestos yarn, braided in round cross-section in the braid-over-braid construction, thoroughly lubricated and graphited throughout.

STYLE 899 (F.O.P.)—U. S. COMPRESSED ASBESTOS SHEET

F.O.P. (Fibre Oil-Proof) is the original oil-proof asbestos fibre high-pressure sheet developed especially for oil industry conditions. Recommended for packing flanges or joints against superheated or saturated steam, air, ammonia, gases, oil, gasoline, water, some acids, alkaline solutions and other chemicals. Ideal for Still Head gaskets. It will not soften, burn, blow or ooze out of a joint, and does not deteriorate with age in stock.

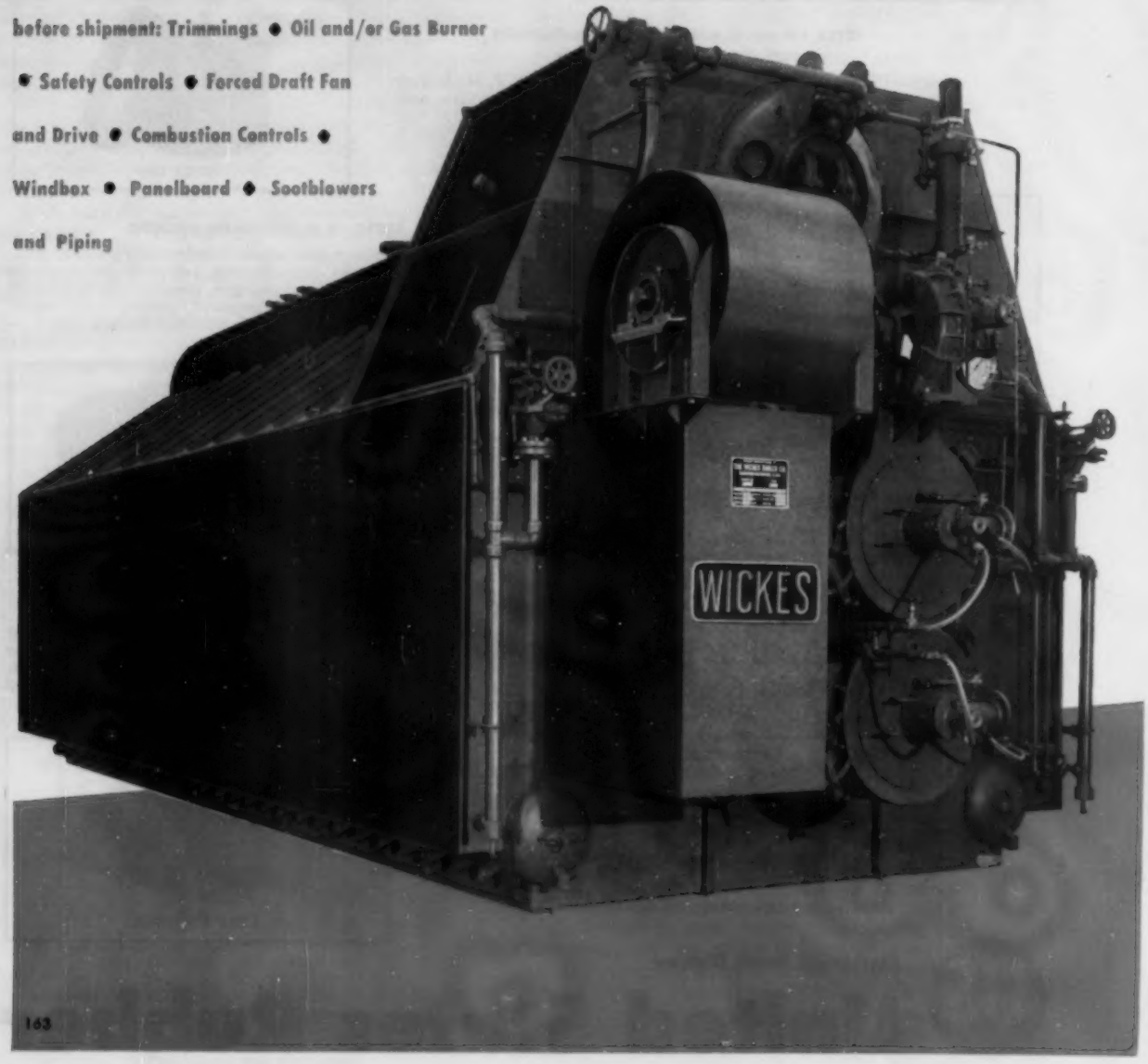
STYLE 899 (F.O.P.)

US RUBBER **Mechanical Goods Division**

United States Rubber

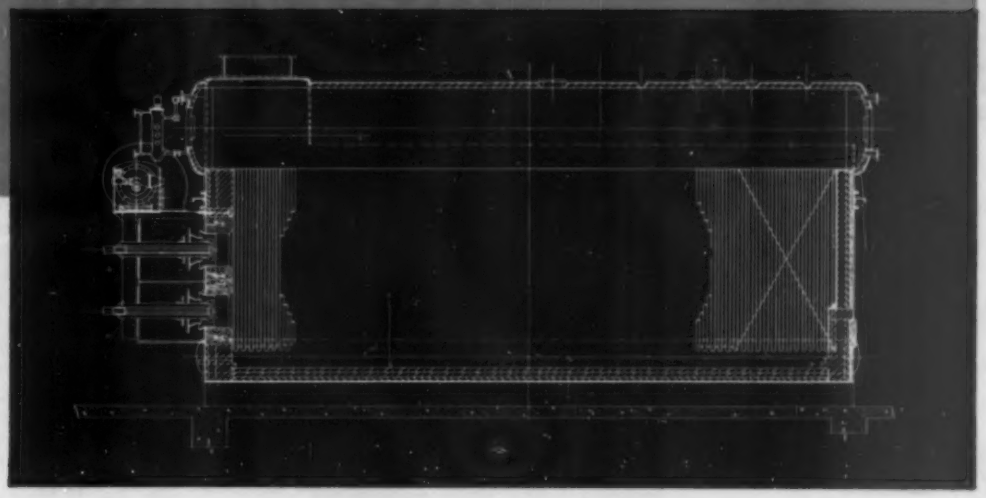
NOW! 60,000 LBS. PER TYPE-A WATER TUBE by WICKES

Wickes Type-A Boilers include the following auxiliary equipment, installed before shipment: Trimmings • Oil and/or Gas Burner • Safety Controls • Forced Draft Fan and Drive • Combustion Controls • Windbox • Panelboard • Sootblowers and Piping



163

HOUR WITH A SHOP-ASSEMBLED STEAM GENERATOR



With capacities for sustained steam production up to 60,000 lbs. per hour the Wickes Type-A Boilers give you "packaged power" ready for immediate installation. They are custom engineered to your requirements and shop-assembled to reduce interruption of operations in your plant to a minimum. Wickes Type-A packaged boilers conserve head-room and floor space and are very simple in design . . . the large furnace is located between two banks of boiler tubes so that each furnace wall is a separate steam generator as well as an integral part of the boiler unit. The steam generator is enclosed in a high quality refractory and insulation setting and protected by a pressure-tight steel casing . . . thus, the pressurized furnace can be operated without a high stack or induced draft fan when burning oil or gas. This casing is also completely weatherproof for outdoor installation.

THE **WICKES** BOILER CO.

WICKES type A

Write for our Catalog 56-1 for detailed information on Wickes Type-A Boilers and we will also include our Bulletin 55-1 covering the complete line of Wickes Products and Facilities.

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Recognized Quality Since 1854 • Sales Offices: Albuquerque, N. M. • Boston • Buffalo • Charlotte, N. C. • Chicago • Cleveland • Dallas Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Portland, Ore. Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D. C.

zle-mixing burners are probably due to the difference in the mechanism of combustion of hydrocarbon gases and hydrogen. When a hydrocarbon gas is ignited, a small portion of the gas is cracked to hydrogen and carbon, and the incandescent particles of the slower burning carbon act as a catalyst for further oxidation of the hydrogen, the aldehydes and ketones formed by partial combustion, and the undecomposed hydrocarbons. When hydrogen is burned alone or in mixtures with small amounts of hydrocarbons, practically no carbon is formed by cracking, and in the absence of catalytic action of the incandescent carbon particles, combustion is much slower, unless it is accelerated by high turbulence in the ignition zone. Therefore, nozzle-mixing burners for high-hydrogen gases are designed for higher jet velocities than for hydrocarbons so that the gas jets can entrap more air as primary for ignition and produce more turbulence after ignition.

Oil Burners

Main function of an oil burner is to convert liquid fuels, which do not burn as such, into a combustible mixture with air. Combustion of liquid fuels is a surface phenomenon and occurs only when the finely divided liquid is dispersed through the air and converted into a vapor or gas by partial oxidation, evaporation, or thermal cracking. Usually all three mechanisms are involved.

TABLE 5. Combustion characteristics of fuel gases.

	Methane	Ethane	Propane	Hydrogen
Specific gravity	0.551	1.049	1.562	0.07
Cal. value, HHV				
Btu/cu ft	1,013	1,792	2,590	325
Btu/lb	23,880	22,320	21,660	61,100
Air for theor. comb				
cu ft/cu ft	9.53	16.68	23.82	2.38
lb/lb	7.53	13.18	18.82	34.34
Theor. mixture				
Btu/cu ft, LHV	86.5	98.1	96	81.5
Btu/lb, LHV	1,175	1,195	1,195	1,460
Specific gravity, air=1.0	0.97	1.03	1.02	0.75
Volume per cent of comb.	9.47	5.64	4.04	29.5
Exper. flame temp., F	3,407	3,443	3,497	3,713
Limits of inflammability				
Volume per cent in mixture				
(a) Lower	5	3.10	2.10	4
(b) Upper	15	12.45	10.10	74

When a droplet of oil surrounded by air is subjected to a temperature above the flash point, the low-volatile constituents are evaporated and ignited and the surface of the remaining high-volatile portion of the droplet is sufficiently preheated by the ignition to be partially oxidized. This further raises the surface temperature of the droplet and causes evaporation and thermal cracking of the remainder of the droplet, forming carboids as the last residual product. If the droplet is small, so that it has a large ratio of surface to mass, and if it is surrounded with sufficient air in turbulent motion, the droplet will be completely burned within the confines of the visible flame. If the droplet is large, or if the turbulence in the ignition zone is not sufficient to purge the combustion products as they are formed from the surface of the droplet and bring fresh air in contact with the surface, cracking may proceed faster than combustion and the carboids converted into carbon of a graphitic nature. This carbon is harder to burn than the gases and vapors produced on ignition, and the carbon will persist as incandescent particles in the flame, particularly around the periphery, as smoke, unless completely burned within the hot portion of the flame with considerable amounts of excess air. With very large droplets, cracking produces relatively coarse carboid particles, which upon cracking are thrown out from the flame as "fire flies."

Two Atomizing Methods

According to methods of atomization, oil burners can be divided into two main parts—mechanically atomizing burners and impact atomizing burners. In mechanically atomizing burners, the oil is broken up by centrifugal force of rotary motion produced by the nozzle. In impact atomizing burners, the oil is emulsified by impact with high-velocity jets of steam or compressed air. Air atomization is used only when steam is not available.

Mechanically atomizing burners are seldom used on process heaters. Generally these burners operate best at capacities over 50 gph and within a range of 75-125 per cent of the nominal rating. Most process heaters are designed for multiple-burner firing with burners of lower capacity. When fuel oil is burned alone for start up and as a subsidiary fuel during the run, the oil burners on a process heater may have to be turned down to less than half of the rated capacity.

Impact atomizing burners can be divided into two types —single-step externally atomizing, where the impact occurs outside of the burner tip, and two-step internally atomizing, where the first stage of atomization occurs inside a mixing tube by impact and the second stage at the outlet of the burner nozzle by expansion. Fig. 15A shows two general types of externally atomizing burners. In one, a single oil stream is impinged upon by a number of jets directed towards the center of the stream. In the other, the oil is forced through the openings into the center of a venturi-shaped flat passage for the atomizing fluid, which shears off the oil in thin pancakes and breaks it up by turbulence and expansion in the expanding portion of the passage. Fig. 15B shows two types of internally atomizing burners. In one, the primary atomization is by impact and piercing of the oil stream by a number of jets at right angles to the stream and by turbulence within the mixing tube, and in the other, by shearing in the throat of a venturi and turbulence in the expanding portion of the venturi. In both types, secondary atomization is obtained by expansion through the burner nozzle.

Single and Twin Burner Blocks

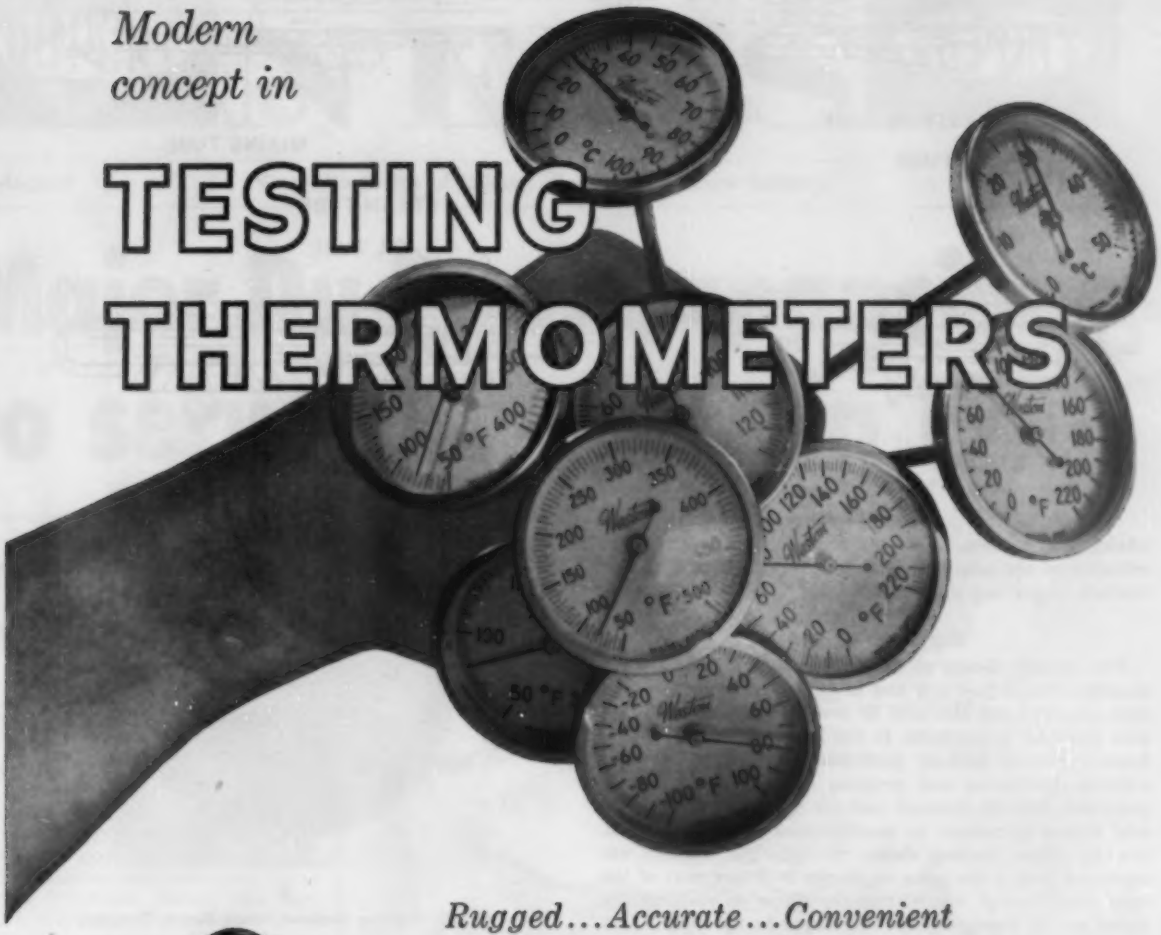
Most fuel oil burners are equipped with a single-burner block. The largest portion of the total air used for combustion is induced through the block by the steam-oil jet from the burner and is mixed with the jet as primary air. The remainder of the air is drawn in by the draft and acts as secondary air. In well designed burners, the shape of the jet is correlated with the contour of the block to produce an incandescent surface near the outlet from the block and eddies near the root of the flame and turbulence for intimate mixing of the total air with the oil. Some burners have a slotted cone around the burner tip that imparts a rotary motion to a portion of the air used as primary and produces turbulence around the cone. This stabilizes the flame and helps to mix the remaining air with the ignited fuel. The cone helps to produce clean flames with low excess air, but it can only be used with fuels that do not form "whiskers" on the tip because the cone interferes with cleaning the tip. Fig. 15C shows an oil burner with a turbulence cone and an air register that imparts a rotary motion to the total air.

The twin-burner block as shown with the gas burner in Fig. 13F was originally designed for and used exclusively with a particular type and make of oil burners for the heavier residues. The twin block is standard in heaters J and K for any type of fuel oil. As with gas firing, the first block is the ignition block where the fuel is mixed with the primary air and ignited, and the flame stabilized by the eddies at the root. The inside contour of the second block is correlated with the shape of the ignited fuel-air mixture so that the periphery of the flame, after it is mixed with the secondary air, glances over the surface of the second block near its outlet to provide incandescent refractories. This is the main difference in the function of the twin-burner block as used with oil burners and with nozzle-

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

Modern concept in

TESTING THERMOMETERS



Precision POCKET THERMOMETERS

Dials 1" dia. – spike stem 5" long – 18-8 stainless steel construction – ranges as low as −40F to high as +500F – accuracy ½ of 1% of thermometer range.

General Purpose THERMOMETERS

Dials 2" dia. – 18-8 stainless steel construction – ranges as low as −100F to high as +1000F – accuracy 1% of range.

Model 2282 – standard stem length 8" including hub.

Model 2281 – stem lengths 2½"-4"-6"-9"-12"-18"-24" including threads

Rugged...Accurate...Convenient for laboratory and equipment needs

For laboratory needs, for production testing and inspection, for equipment mounting . . . wherever high sustained accuracy and quick response are essential . . . WESTON all-metal thermometers have been widely adopted because they are more convenient to use, and far more durable and economical. Cases and stems are of 18-8 stainless steel – standard stem length 8" – 2" to 24" length available on order – dials 1¾" dia. – ranges from low as −100F to high as +500F. Require only 2" immersion in solids or liquids. Accuracy ½ of 1% of thermometer range. For the complete story, including data on all-metal thermometers for industrial use, write now for bulletin T-13. Weston Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J. A subsidiary of Daystrom, Incorporated.

WESTON *all-metal*
THERMOMETERS

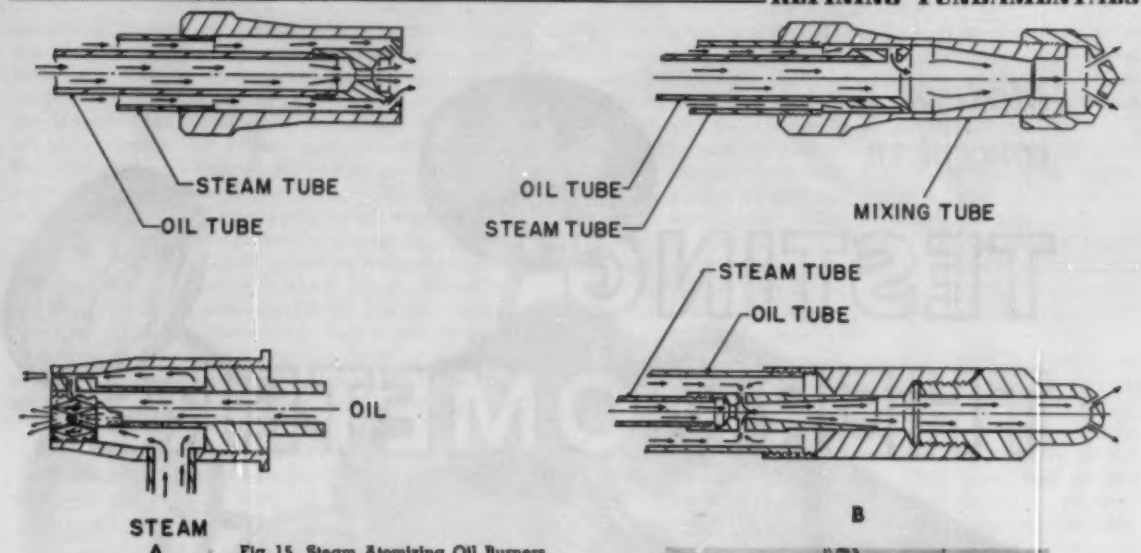


Fig. 15. Steam Atomizing Oil Burners.

C

Fig. 15C Courtesy National Airoil Burner Company

mixing gas burners. With gas burners, the incandescent refractories are produced in the first block by the ignited mixture of gas and primary air.

Burning Pitches

The burners shown on Fig. 15 were developed to burn standard No. 6 fuel oils and normal blends of unsalable high-viscosity and B.S. and W content residues with surplus distillate by-products. In the last few years, some refineries started burning pitch-like residues from deep-vacuum distillation and propane de-asphalting units as produced, without cut-back and are doing this with a certain degree of success in modifications of these burners. Usually when burning these residues, the burners are equipped with a gas pilot to supply 5-10 per cent of the total liberation at the root of the flame to stabilize the flame and to provide extra turbulence in the combustion zone by ignition of the gas. Best results with burning pitch-like residues in modifications of conventional burners are obtained with twin-burner blocks.

Fig. 16 shows a combination oil and gas burner recently developed for general refinery use and particularly for burning high-hydrogen content gases and heavy fuel oils, up to the pitch-like residues. The burner uses forced draft at approximately 6 in. W.G. in the wind box. With gaseous fuels and with the normal refinery fuel oil blends, the burner can be operated with cold air. With pitch-like residues air preheated to 500 F and higher gives the best result. Fig. 16A shows the so-called "Y-head" steam atomizing oil gun. Atomization is at the tip by impact between the steam, supplied through one arm of the Y, and the oil as it enters the other arm. Fig. 16B shows the general arrangement of the combination burner. The total air is admitted tangentially through three directional louvers into the narrow portion of the cone-shaped air chamber to give the air a high-velocity screw rotary motion with a vortex traveling toward the outlet of the cone. The vortex produces secondary atomization of the oil and thorough mixing of the air with the atomized oil before the mixture is ignited in the burner block. The turbulence produced in the block by expansion and contraction of the mixture within the block helps to complete ignition within the block and to stabilize the flame. With gas firing, the gas is discharged into the cone through three groups of orifices located between the louvers. The rotating air sweeping across the orifices brings the gas into the vortex where the gas is intimately mixed with air before the mixture enters the burner block, so that, in effect, the burner is a fully premixing gas burner.

As of to date, this burner is the nearest approach to a combination oil and gas burner in which the burning requirements of either fuel have been given equal emphasis in the basic design.

Burning of pitch-like residues is more of a necessity abroad than in the United States because in most localities abroad there is only a limited market for asphalt and no facilities to coke the residues. Considerable progress was made in Europe in developing special burners to burn these residues with low excess-air and flame characteristics normally obtained with gas or the best grades of commercial residual fuels.

Fig. 17 shows two modifications of a burner for pitch-like residues. The burner, originated by an American process engineering and construction company and developed jointly by that company and the European affiliate of one of the major international oil companies, has been in commercial operation for the last four years burning a wide range of fuels from straight recycle stock to straight asphalt. Fig. 17A is primarily a short-flame burner that can burn pitch-like residues with gas-like flames with less than 20 per cent excess air. The burner and the burner block are designed as a unit with definite relationship between the shape of the spray of atomized oil, the size and shape of the air chamber, and the diameter and length

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

DU PONT

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT

August ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

Major Du Pont expansions to serve TEL users in 1957

TEL TO BE TRANSPORTED BY TANKER FOR FIRST TIME

New Installation at Beaumont Insures Ample Supply at all Times

There will be *three* major distribution points for Du Pont TEL by the first of the year. A new tanker-supplied storage and delivery terminal is now being built in Beaumont, Texas. This new facility will offer the same delivery service and assurance of dependable supplies as the two Du Pont TEL manufacturing plants at Carney's Point, N. J. and Antioch, Calif.

The Beaumont terminal will be supplied from Du Pont's Chambers Works plant by a specially-designed tanker. Her initial TEL cargo will mark the first time tetraethyl lead compounds have been transported over water in bulk.

DESIGNER'S SKETCH of the special Du Pont TEL tanker. The cylinders you see in the midship section are for TEL. The ship will be painted a distinctive green and yellow.

In addition to this terminal, the Du Pont Petroleum Chemicals Division maintains a sales office, regional laboratory and warehouse in Houston . . . offering full additives service for refiners in the Gulf Coast area.

***THIS MAP SHOWS** that Du Pont facilities for serving TEL customers are located close to the major refining areas.*

ADDED SUPPLY FOR WEST COAST REFINERS

New California TEL plant to be in production by end of this year

Already more than 50% completed, the new Du Pont tetraethyl lead plant at Antioch, California, is expected to go on stream before the end of 1956. So if you operate a refinery on or near the West Coast, you can plan on a handy source of supply for your TEL requirements next year.

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

CONTINUED **New Plant**

The new plant is located approximately two miles east of Antioch on the San Joaquin River. This makes it readily accessible to both water and rail transportation. Added to existing Du Pont facilities, the new plant will for the first time provide West Coast refiners with TEL that is West Coast-*made*. The plant will enable us to give nearby customers the fastest possible delivery service, with ample stocks always on hand.

Modern design

The latest technical advances in tetraethyl lead manufacture have been incorporated into the design and equipment—making it the most modern TEL plant in the world.

Expanding need

Due to the rapid expansion of the West Coast refining industry, there is a definite need for the new California plant. It will supply refineries in California, Oregon, Washington, Arizona, Nevada, Idaho, Montana and British Columbia.

Architect's sketch of the new Du Pont TEL and "Freon" plants at Antioch, California.

Integrated facilities

Added to the present Du Pont Petroleum Chemicals Division regional laboratory at El Monte and sales offices in Los Angeles, San Francisco and Seattle, the new TEL production facilities at Antioch will mean completely coordinated facilities for manufacturing and servicing the area's needs for TEL.

Sharing the same site is a new plant for making Du Pont "Freon"* refrigerants and propellents. This plant is now practically completed.

The Antioch plant will become an important new consumer of local materials, and when completed, the new Du Pont TEL facilities alone will provide production jobs for 215 employees. Most of them will be hired locally.

*Registered trademark

WEST COAST MEDICAL SUPERVISOR

LAWRENCE A. GERLACH, M. D., is stationed at Antioch, Calif., in charge of the various Du Pont medical services in connection with the manufacture and distribution of tetraethyl lead in the Western Region.

He joined the medical staff of the Du Pont Company in 1947 and was assigned to the Petroleum Chemicals Division. Recently, due to the increasing refining activity and demand for TEL along the West Coast, he was transferred from Wilmington and stationed in this area. Prior to World War II, he was engaged in private medical practice in New York City and also served as Flight Surgeon, U. S. Naval Reserve.

In 1940 he joined the U. S. Army Air Corps Reserve as a pilot. He was called to active duty as a test pilot, in which capacity he served throughout World War II. He was returned to inactive duty with the rank of Lt. Colonel in 1947.

Dr. Gerlach was awarded the Air Medal and Distinguished Flying Cross for his military service. He is a Fellow of the American Medical Association and also holds a Fellowship in the Industrial Medical Association.

He is co-author of the book, "Maintaining Hygiene in TEL Operations."

LAWRENCE A. GERLACH, M. D.

Nationwide Du Pont TEL storage and delivery facilities serve refiners

To assure you of an ample supply of TEL compounds at all times, the Du Pont Petroleum Chemicals Division maintains—in addition to shipping facilities at the two plants and Beaumont—15 rail sidings and tank truck terminals.

These rapid-delivery facilities are conveniently located adjacent to the major refining areas of the country . . . at Ferndale, Washington; Port Costa (San Francisco), Torrance and El Monte, California; Salt Lake City, Utah; Houston, Corpus Christi, Chaison and Texas City, Texas; Kansas City, Missouri; East Chicago, Indiana; Minneapolis, Minnesota; Wood River, Illinois; Toledo, Ohio; and New Orleans, Louisiana.

Fast Service

Always on hand at all distribution points is an ample supply of both Motor and Aviation Mix. And there is someone ready at the phone to receive your order at any time of day or night.

Warehouses, too

For all Du Pont additives other than tetraethyl lead, we maintain fully stocked warehouses at Los Angeles, Houston, Billings, Montana; Kansas City, Missouri; Chicago and Carney's Point, New Jersey. Your orders can be filled promptly from any of these points — around the clock.

DU PONT

Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

Sales Offices:

CHICAGO 3 — 8 So. Michigan Ave. ..... RAndolph 6-8630
CLEVELAND 14 — 1321 National City Bank Bldg. ..... MAin 1-6460
HOUSTON 2 — 705 Bank of Commerce Bldg. ..... CApitol 5-1151
LOS ANGELES 17 — 612 So. Flower St. ..... MAdison 5-1691
NEW YORK 20 — 1270 Ave. of the Americas ..... COlumbus 5-2342
PHILADELPHIA 2 — 3 Penn Center Plaza ..... LOcust 8-3531
PITTSBURGH 22 — Room 751, 1 Gateway Center ..... ATlantic 1-2933
SAN FRANCISCO 4 — Room 626, 111 Sutter St. ..... EXbrook 2-6230
SEATTLE 3 — Room 215, 4003 Aurora Ave. ..... MElrose 6977
TULSA 1 — P. O. Box 730, 1811 So. Baltimore Ave. ..... LUther 5-5578

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals—85 Eglinton Avenue East—Toronto 12, Ontario—HUdson 1-6461
OTHER COUNTRIES: Petroleum Chemicals Division—Export Sales—Room 7496, Nemours Bldg.—Wilmington 98, Del.—OLympia 4-5121, Ext. 2962

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-2337

Printed in U. S. A.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

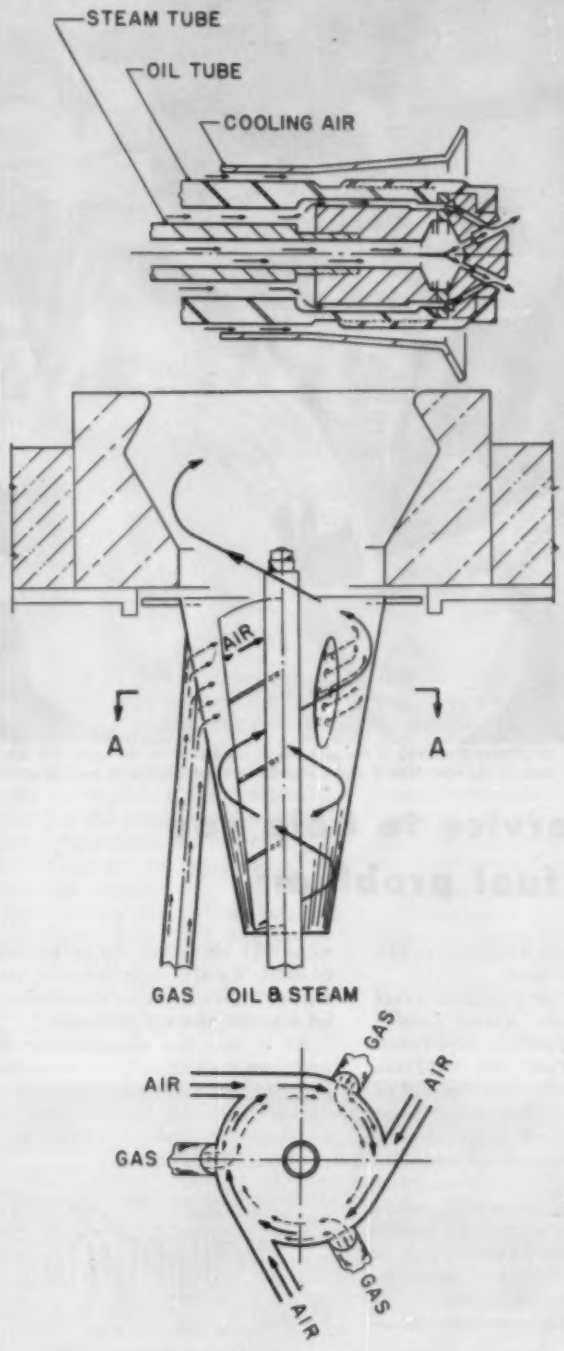


Fig. 16. Combination Oil and Gas Burner.
Courtesy Babcox and Wilcox Company

of the burner block for each range of capacities. The total air required for combustion is supplied at a pressure of 16-20 in. W.G. and is given a rotary motion with high linear and angular velocities by carefully designed vanes. Atomization is accomplished in three ways—by mechanical or steam atomization in the burner gun, by impact of the rotating air upon the spray from the gun, and by expansion of the mixture of air with the atomized oil as the mixture enters the burner block through the restricted throat of the air chamber. The ignited fuel-air mixture produces two sets of eddies that stabilize ignition, bring

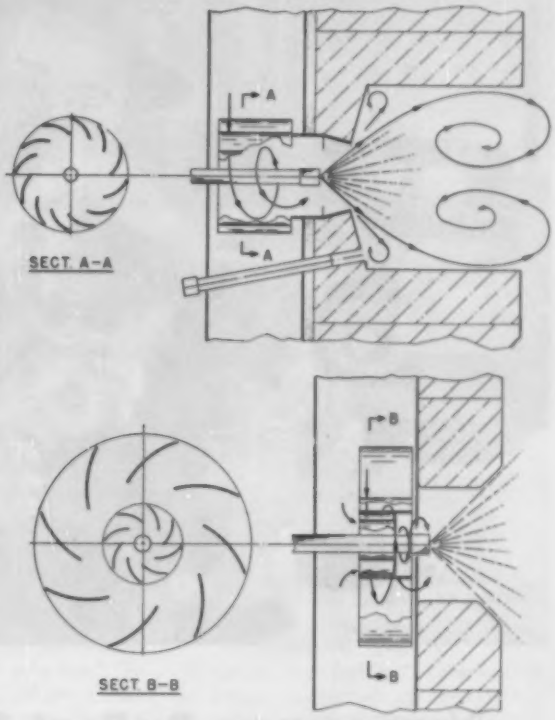


Fig. 17. Burners for Pitch-like Residues.
Courtesy The Lummus Company

hot products of combustion into the center of the flame, and assist in completing combustion within the block. The rotary motion of the flame and the eddies near the outlet dissipate most of the kinetic energy of the flame within the burner block so that the products of combustion leave the burner at very low velocities. This reduces the danger of flame impingment on tubes close to the burners.

Fig. 17B shows the same type of burner for application where relatively long flames are desirable. In this modification, the total air, also supplied at 16-20 in. W.G., is split into primary and secondary. The primary air, given a high-velocity rotary motion by one set of vanes, is used for impact atomization. The secondary air, made to rotate at high velocities by another set of vanes in an opposite direction, is mixed with the ignited fuel beyond the ignition point. The high turbulence produced by the opposing rotary motions of the primary and secondary air assists in stabilizing the flame and in thorough mixing of the fuel with the total air.

Use of high pressure on the total air and the definite dimensional relationships between the components of burners in Fig. 17A and 17B, which impart to the burner their advantages of fine atomization and pattern of ignition and combustion, are also the cause of two principal disadvantages of the burner—high power requirements for the forced-draft fan and low turn-down ratio without an increase in excess air. The burners operate best between 100 per cent and 60 per cent of rating. At lower capacities, the quantity and velocity of air are reduced too much for satisfactory secondary atomization and turbulence, and higher amounts of excess air are required than can be used at capacities near the rating to produce clear flames with the desired pattern.

INJECTOR-STICKING is the problem at hand here. In this case, a combination of Du Pont FOA-2 and Metal Deactivator proved to be the solution.

Now—a new Du Pont Service to help you solve diesel-fleet fuel problems

When a diesel operator encounters a fuel problem—such as injector-sticking or filter-plugging—he often tends to blame the refiner for his troubles. And with a big fleet operator, such complaints are likely to jeopardize a substantial amount of business. It is at this point that your customer relations can often be improved by the analysis and opinions of a third party, a Du Pont technical representative backed up by numerous Du Pont facilities.

To help you solve these problems as quickly and easily as possible, our Du Pont Petroleum Chemicals Division automotive specialists will be glad to work with your men. Their practical experience with this type of problem can be added to your own experience. And our five conveniently-located regional laboratories, as well as the main Du Pont Petroleum Laboratory, can also aid you in this work.

In cases where filter-plugging occurs—in both truck and tractor fleets—our service representatives have found that Du Pont Fuel Oil Additive No. 2 (FOA-2), or a combination of FOA-2 and Du Pont Metal Deactivator (DMD) helps overcome the trouble. This same combination of additives has proved helpful also in overcoming injector-sticking. However, since different diesel fuel stocks vary considerably in composition and response to additives, each problem must be studied on an individual basis.

Different diesel engine injector designs may also affect the performance of fuels. We are, therefore, also working with diesel engine manufacturers on injector-sticking problems.

So if you are encountering fuel problems with any of your accounts, it may pay you to discuss them with one of our automotive specialists. And you can request this service through any of our offices listed below.

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

Sales Offices: E. I. DUPONT DE NEMOURS & COMPANY (INC.) • Petroleum Chemicals Division • Wilmington 98, Delaware

CHICAGO 3—8 So. Michigan Ave. ..... RAndolph 6-8630
HOUSTON 2—705 Bank of Commerce Bldg. ..... CApitol 5-1151
LOS ANGELES 17—612 So. Flower St. ..... MAdison 5-1691
NEW YORK 20—1270 Ave. of the Americas ..... COlumbus 5-2342
PHILADELPHIA 2—3 Penn Center Plaza ..... LOcust 8-3531
PITTSBURGH 22—Room 751, 1 Gateway Center ..... ATlantic 1-2933
SAN FRANCISCO 4—Room 626, 111 Sutter St. ..... EXbrook 2-6230
SEATTLE 3—Room 215, 4003 Aurora Ave. ..... MElrose 6977
TULSA 1—P. O. Box 730, 1811 South Baltimore Ave. ..... LUther 5-5578

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals—85 Eglinton Avenue East—Toronto 12, Ontario—HUdson 1-6461
OTHER COUNTRIES: Petroleum Chemicals Division—Export Sales—Room 7496 Nemours Bldg.—Wilmington 98, Delaware—OLympia 4-5121, Ext. 2962

JET ENGINES

And Their Probable Future

The regenerative gas turbine will power 10 per cent or more of this country's new passenger cars and trucks by 1965.

William P. Barnes
Associate Professor of Mechanical Engineering, University of Utah

THIS paper is presented, not as an earth shaking introduction of top secret data on jet engines, but rather in the hope of assisting the reader in formulating a better picture of the role of the jet engine in the foreseeable future. For the purpose of this presentation, I have taken the liberty to define "jet engine" as "any continuous combustion engine."

Entry of the gas turbine into the transportation field might seem rather slow to those of us following its development. When compared to the more than 50 years required to bring the present automotive piston engine to its present dependable state, the past 7 to 8 years have seen tremendous strides taken by the "tornado in a box." To better understand the probable future status of this unique power plant in road vehicles, let us consider some of the basic reasons for its popularity.

1. Rotary motion vs reciprocating motion

Smoother power with less vibration and fewer lubrication and maintenance problems favor the rotary turbine over the reciprocating engine.

2. High horsepower / weight ratio
3. High horsepower / volume ratio
4. Free-power turbine unit needs no torque converter or automatic transmission (Fig. 1)

When the "free-turbine" engine is used, a torque conversion up to 2½:1 is possible at power turbine stalled condition. Since no physical connection exists between the gasifier turbine driving the compressor and the power turbine, complete freedom of operation is obtainable.

5. No high octane requirements needed for gas turbine fuels
6. The gas turbine is air cooled and has little, if any, oil consumption

*Presented at the Rocky Mountain Oil and Gas Association, Salt Lake City, Utah, April 26 and 27, 1956.

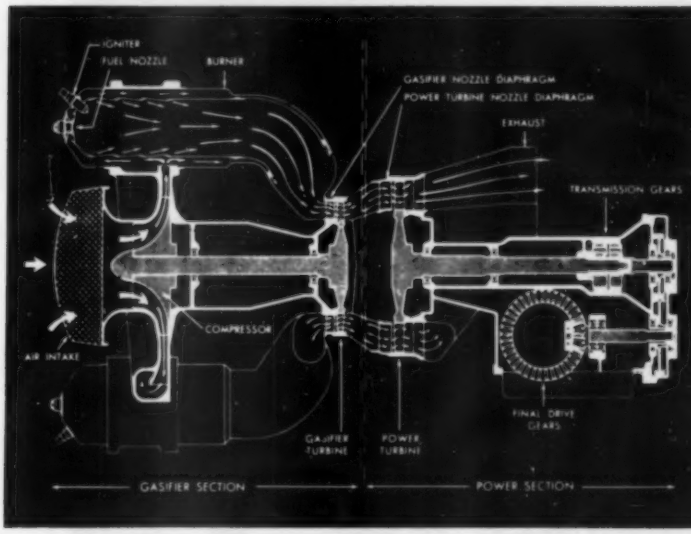


FIG. 1. Essential details of General Motors experimental gas turbine for ground vehicles.

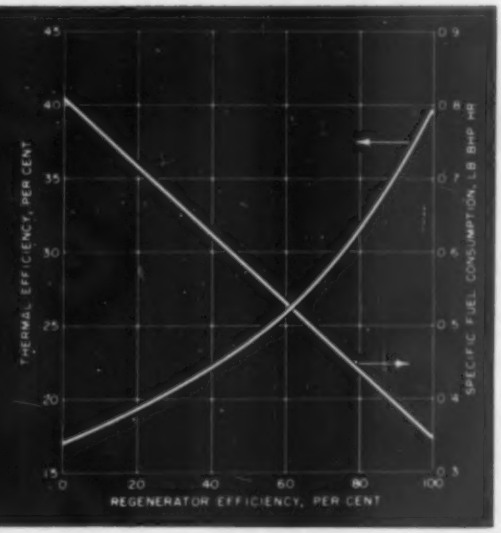


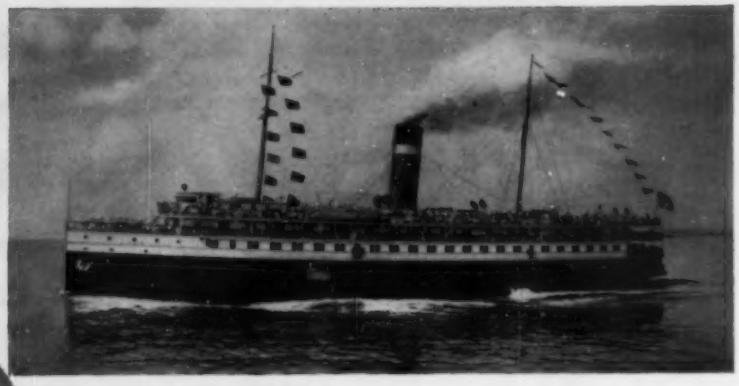
FIG. 2. Effects of regeneration on thermal efficiency and specific fuel consumption.

BETHLEHEM

AMERICA'S LEADING SHIPBUILDER·MANUFACTURER OF

MARINE TURBINES

Turbines for the *S.S. Governor Cobb*, at right, first commercial ship in the United States to employ this form of propulsion, were built in 1906 by what is now Bethlehem's Hoboken Yard. For 41 years, until she was scrapped, the original turbines propelled this vessel through a varied career, including service as a U. S. Coast Guard helicopter carrier.



50 YEARS

of Marine Turbine Building

Turbines for the Bethlehem-built-and-engined *S.S. Independence*, above, and her sister-ship, *S.S. Constitution*, are lineal descendants of the *Governor Cobb's* engines and incorporate the accumulated research and experience of almost half a century. Thus, they may be expected to have a similarly long and dependable life.

Internationally recognized for efficiency, dependability and ruggedness, Bethlehem-built turbines always are integrated with the design of the ship and carry the warranty of the world's foremost steelmaking and shipbuilding organization. Furthermore, Bethlehem's shipyards can service these turbines speedily because of their intimate knowledge of these engines and the quick availability of parts and spares. From every standpoint, a good combination *all ways* is the Bethlehem-Built-and-Turbined ship.

SHIP REPAIR YARDS

Boston Harbor — New York Harbor
Baltimore Harbor — Beaumont, Texas
Los Angeles Harbor — San Francisco Harbor

SHIPBUILDING YARDS

Quincy, Mass. — Staten Island, N. Y.
Sparrows Point, Md. — Beaumont, Texas
Terminal Island, Calif. — San Francisco, Calif.

BETHLEHEM STEEL

Shipbuilding Division

GENERAL OFFICES: 25 BROADWAY, NEW YORK 4, N. Y.

On the Pacific Coast shipbuilding and ship repairing are performed by the Shipbuilding Division of Bethlehem Pacific Coast Steel Corporation

Thus far a rosy picture has been painted. It now behooves us to look at some of the present shortcomings of the vehicular gas turbine and discuss the probable methods of overcoming the more serious problems:

A. Adverse effect of high operating temperatures on the strength of materials

B. Difficulty of obtaining high combustion efficiency with extremely lean mixtures.

In order to have continuous combustion and, at the same time, keep turbine inlet temperatures below 1600F, it is necessary to use very lean mixtures. These range from fuel-air ratios of 0.01 at full power where less than 15 per cent of the available oxygen is used to F/A ratios of 0.0011 at idling conditions. Gas speeds through the combustor are on the order of 50 ft/sec, far higher than the flame speeds for most turbine fuels in quiescent mixtures (less than 10 ft/sec). This situation results in flame blowout unless high turbulence and a stable flame front are established in the combustor.

C. High fuel consumption and low thermal efficiency at part load

Effect of compressor and turbine efficiencies and pressure ratio on turbine performance is very critical. Approximately two-thirds of the total power developed in the turbine blades must be used for air compression. A practical answer to these low thermal efficiencies is *regeneration*. Maximum turbine performance with regeneration is obtained with *lower pressure ratios*, especially at *part load conditions*. At full throttle conditions, a regenerative gas turbine of 75 per cent efficiency gives better specific fuel consumption than a comparable 8:1 compression-ratio piston engine. (Fig. 2).

D. Large variation in horsepower with compressor inlet temperature

At 120 F, for example, thermal efficiency decreases 2 per cent, and only 74 per cent of rated power at 60 F can be developed.

E. Poor acceleration characteristics

F. High pressure losses due to high mass rates of air flow

A gas turbine will require 12,000 lb of air per hour compared to 2000 lb

Curb Dangerous Sparks

...by using spark-resistant Ampco Safety Tools in hazardous locations

Wherever hot sparks could start a costly fire, the protection of Ampco Safety Tools is the cheapest "insurance" you can buy. This small investment today can prevent a big loss tomorrow.

That's why Factory Mutual Laboratories and other safety authorities approve and recommend Ampco Safety Tools for use in hazardous locations.

Select the right Safety Tool for every job, from the more than 400 items that make the Ampco line the world's most complete. Write for new catalog ST-10.

AMPCO METAL, INC.
Dept. PE-8, Milwaukee 46, Wisconsin
West Coast Plant • Burbank, California
In Canada . . . it's Safety Supply Company, Toronto, Ontario

AMPCO ®
T-168
THE METAL WITHOUT AN EQUAL

How to choose Safety Tools
For tools subject to impact and/or torque — specify Ampco Metal Tools.
For tools that have cutting edges or gripping teeth — specify Ampco Beryllium Copper Tools.
For tools to be used in the vicinity of acetylene or similar gases, specify Ampco Monel* Tools.
*T.M. International Nickel Co.

per hour for its piston engine counterpart.

G. Noise

The high rate of air flow, especially through the intake screen and into the centrifugal compressor, results in a high-pitched "scream." However, intake mufflers combined with under-the-hood soundproofing have brought this noise below the objectionable level.

H. Cost

This is the $64 question! No one at this time believes the regenerative gas turbine can be produced for less than the piston engine. It is a proven fact, nonetheless, that, since Henry Ford and the Model T, mass production has been producing miracles in lowering the selling price.

Now is the time to unwrap tomorrow's 200-hp, passenger-car gas turbine engine. It will probably have:

(1) A pressure ratio of 4:1 at full power and 1.2:1 at idling

(2) Single-stage centrifugal compressor and impulse turbine with efficiencies on the order of 80 per cent

(3) Full-power, turbine inlet temperature of 600 F

(4) A regenerator having an efficiency of 90 per cent at idling and 75 per cent at full power

(5) Maximum compressor speeds of 50,000 rpm and idling speeds of 15,000 rpm

(6) Transmission gearing between the free-power turbine (30,000 rpm) and the drive shaft (4000 rpm maximum)

(7) Fuel mileage of 20 mpg at 20 mph, 16 mpg at 40 mph, and 14 mpg at 60 mph. It is worthwhile to note that a Plymouth car powered by a regenerative gas turbine has been touring the U. S. since about April 1. Its fuel mileage is stated to be 14.8 mpg at 40 mph.
Ford Motor Company has announced recently that the best economy for its gas turbine was 17¼ mpg at 40 mph falling off fairly rapidly at higher and lower speeds. General Motors announced several months ago that its gas-turbine passenger car would give mileage comparable to current piston engine cars.

(8) Fuels of medium volatility and low octane number. The aircraft turbine has shown quite a dislike to aromatics boiling at over 400 F. Forgetting cost and specific fuel consumption, methanol is probably the best ideal liquid fuel for a gas turbine. Perhaps the liquefied petroleum gases can be satisfactorily utilized. From a more practical viewpoint, the automotive gas turbine will most likely use low-octane motor gasoline or JP 4, which in practice is about two-thirds gasoline.

In the long range analysis, the reciprocating engine is still king below 350 five major jet engines in the aeronautical field — the turbojet, turboprop, turboramjet, ramjet and rocket. From a specific fuel consumption standpoint, the turboprop is best (0.6 to 1.0 lb/hp-hr) and the turbojet, turboramjet, ramjet and rocket (15 to 20 lb/lb thrust-hr) follow in that order.

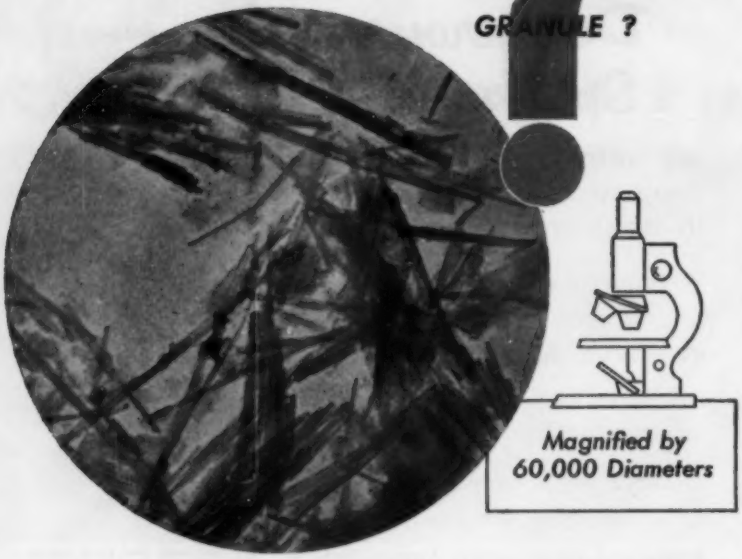
In the long range analysis, the reciprocating engine is still king below 350 mph, the turbojet is best up to Mach 2 (twice the speed of sound), and the ramjet shows to highest advantage from Mach 2 to Mach 4. The rocket has very poor range at all speeds.

When considering net thrust per engine weight, the rocket overshadows all other jet engines with 40 lb thrust per pound weight. Only the ramjet approaches this value at Mach 3.5. Turbojets and turboprops have exceedingly

EVER LOOK INSIDE A

Florex ?

GRANULE ?



The fibrous nature of Florida Fullers Earth, commercially available as Florex, reveals each unit consisting of about 2200 molecules in a bundle, providing ready selectivity in adsorption of color and contamination from organic and inorganic liquids and gases.

Florex quality means specially processed fullers earth giving maximum surface area and adsorption efficiency. Florex is unequalled in high quality or low cost for processes involving the use of highly active clay for sweetening light distillates, dehydration, desulfurization, and polymerization.

Standard meshes from 2/4 to 200/up and our experienced adsorption specialists are available to help you solve complex laboratory or production problems.

FLORIDIN COMPANY

Adsorbents
Desiccants
Diluents

Dept. D. P.O. Box 989, Tallahasee, Florida

low values of 3 lb thrust/lb weight or less.

In summary, I should like to offer some predictions on the future role to be played by jet engines. Right or wrong, they at least can be used as a basis for argument in the hot stove league.

(1) The turbojet will find more favor than the turboprop in the commercial field in speed ranges of 500 to 700 mph.

(2) Top turboramjet speeds will probably be on the order of 2000 mph.

(3) Ramjets will furnish power for aircraft at speeds of from 1000 to 2600 mph.

(4) Rockets will be used exclusively for manned aircraft or guided missiles flying at speeds above 3000 mph (above Mach 4)

(5) The regenerative gas turbine will power 10 per cent or more of this country's new passenger cars and trucks by 1965.

Acknowledgment

The author wishes to acknowledge the various slides received from S. D. Heron, consulting engineer with Ethyl Corporation, and for the information obtained from Heron's recent SAE paper, "Some Elements of Gas Turbine Performance," March, 1956.

* * *

ERNST
STAINLESS STEEL
GAGE OR IRON

Send for Catalog
Phone Livingston 6-1400
ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J.

O.K. BOYS BREAK IT UP!

Even after sedimentation, separation and chemical treatment of slop oils and refinery waste, you wind up with a knotty problem, that is, a highly stable interfacial emulsion. This is difficult to break, with too much oil in it to lose and too much contamination to allow discharge to waste. That's common knowledge.

But, today, a number of refineries have proved that this problem is easily solved by filtration with Dicalite Filteraids. Dicalite breaks this tough emulsion in two ways. First, the fine solids that help to stabilize the emulsion are filtered out. Second, the oil and water globules are ruptured as they pass through the filter cake. The filter effluent readily separates into oil and water layers... the oil is, of course, already "upgraded" for easier reprocessing, the water is so free of oil (only 2 ppm were found in one State Waterways Authority check) that it may be discharged to waste without danger of stream pollution, or re-cycled for process water in some cases.

Dicalite filtration of refinery wastes recovers 5,300-5,900 bbl. of oil per month for one refinery, making it a highly profitable operation. Others report that oil recovery will pay for the entire filter installation in two years, and then probably show a profit.

Why not investigate the advantages Dicalite filtration can give your operation – write us!

Dependable GLC GREAT LAKES Dicalite® DIATOMACEOUS MATERIALS

DICALITE DIVISION: GREAT LAKES CARBON CORP.
612 S. FLOWER ST., LOS ANGELES 17, CALIFORNIA

IN-BUILT SIMPLICITY...

GUARANTEES

LONG, TROUBLE-FREE SERVICE

Here's the simplest and most efficient pump valve made for reciprocating pumps. The ROYAL CROWN PUMP VALVE has only three separate parts, yet its performance is revolutionary! Valve is guided by a frictionless ball stem which allows it to oscillate and turn with the fluid stream. Swings completely free with each stroke of the pump . . . seating each time in a new position. Resistance to fluid is reduced to a minimum which means greater pump volume at less pump speed. Adaptable to all reciprocating pumps . . . handles all types of liquids.

Royal Crown PUMP VALVES

(A) Round valve surface is streamlined. No obstructions to restrict the flow. (B) Ball-guided valve rotates and swings with each stroke of the pump. Each turn, each swing . . . a lapping action, a continuing perfect seat. (C) Free vertical action assures instant opening and closing. Ball stem is a frictionless guide.

MADSEN WORKS
CONSTRUCTION EQUIPMENT DIVISION
Baldwin-Lima-Hamilton Corporation
14120 EAST ROSECRANS AVE., P. O. BOX 38, LA MIRADA, CALIFORNIA

WRITE FOR DESCRIPTIVE LITERATURE

Moving to a New Address?

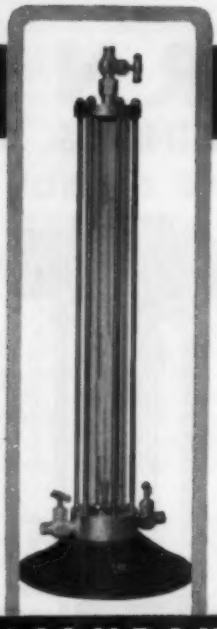
If you are moving or expect possibly to move any time soon, save the coupon below for your convenient change of address. It will prevent your copy of The Petroleum Engineer from being lost or misdirected.

TO: The Petroleum Engineer
P. O. Box 1589 • Dallas
CHANGE MY ADDRESS, beginning with the_____issue

FROM:_____

TO:_____

PRESSURE HYDROMETER JAR



For obtaining specific gravity of liquefied petroleum gases, such as propane and butane, which under normal atmospheric pressure would evaporate into a gaseous form. Jar withstands operating pressures of 200 psi at normal temperatures. Equipment consist of clear lucite tube, aluminum end caps held by tie-rods and a conical base. Three needle valves allow entry of the sample and adjustment of the liquid level.

N.G.A.A. METHOD NO. 2140-55

cenco
The most complete line of scientific instruments and laboratory supplies in the world.
RSC

REFINERY SUPPLY COMPANY
621 EAST FOURTH STREET • TULSA 3, OKLAHOMA
2215 McKINNEY AVENUE • HOUSTON 3, TEXAS

CENTRAL SCIENTIFIC COMPANY
1700 IRVING PARK ROAD • CHICAGO 13, ILLINOIS
CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO
SANTA CLARA LOS ANGELES TORONTO MONTREAL VANCOUVER OTTAWA

CYCOILS take the DUST, leave only CLEAN AIR

Gulf Oil Corporation, at its Odessa, Texas, Sand Hills Plant, depends on AAF Cycoils to keep tough West Texas dust out of its valuable engines.

THIRTEEN big Ingersoll-Rand gas-engine compressors represent a big investment in fine equipment. They deserve the finest protection. And, when they're at work in oil refining, the stakes become substantially higher.

That's why you see that battery of 22 AAF Cycoils protecting the engine air intakes at the Odessa, Texas, Sand Hills Plant of Gulf Oil.

AAF Cycoil heavy-duty oil bath air cleaners provide 4-way cleaning: impingement, scrubbing, cyclonic action and filtering. Over 90% of the fine dust content in the air is trapped in oil and removed by centrifugal action before most of it even reaches the filter pads. Additional filtering pad action provides air that's virtually 100% *dust-free.*

Only Cycoil gives engines and compressors such remarkable protection. Write for Bulletin No. 130. It's the story of Cycoil Oil Bath Air Filter. And it's jam-packed with the kind of facts that save trouble . . . and money.

AAF — American Air Filter COMPANY, INC.
384 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

Type CMS Multi-Duty Filters Type G Pipeline Air Filters

BETTER AIR IS OUR BUSINESS

Type OCH Intake Air Filters Cycoil Oil Bath Air Filters

Announcement!

KOEHRING-PARSONS CO.

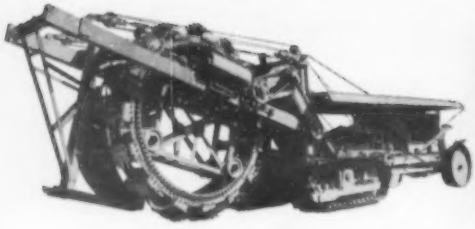
and

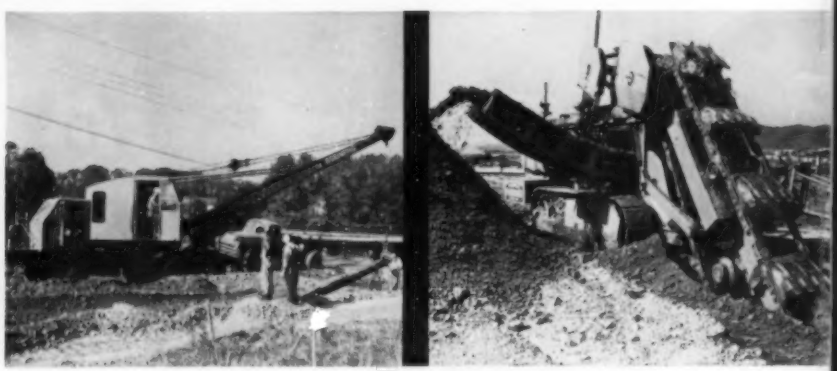
CRUTCHER-ROLFS-CUMMINGS CO.

join hands to bring

Pipe Line Contractors

the world's finest manufacturing and distribution of pipe line excavating equipment





A combination for your benefit . . . the manufacturing talent of Koehring-Parsons Co. and the engineering knowhow and thorough distribution services of Crutcher-Rolfs-Cummings Co. Under a new arrangement, Crutcher-Rolfs-Cummings Co. is now the exclusive distributor in the pipeline contracting field for the Koehring-Parsons complete line of excavating, lifting and trenching equipment. Koehring has acquired the designs and manufacturing rights to the famous C-R-C Big Incher and Middle Incher ditching machines which will be built at Newton, Iowa by the Parsons Co. and sold exclusively through the C-R-C organization. C-R-C, for more than 20 years a leader in the pipeline equipment field, offers to pipeline contractors a complete line of excavating equipment. Koehring has been manufacturing construction equipment since 1906.

PARSONS CO. NEWTON, IOWA *(Koehring Subsidiary)* **KOEHRING CO.** MILWAUKEE, WIS.

PIPE LINE DEVELOPMENTS ★ ★ ★

Roundup of Current Planned and Proposed Construction

The following tables list the company, mileage, pipe size, and location of proposed pipe line projects — crude, products, and natural gas — reported to The Petroleum Engineer. Company addresses are given where furnished or known.

CRUDE LINES

Name of Company	Miles	Size	Location
Ar-Mex Pipe Line Company, Dallas, Texas	790	12–14	Guernsey, Wyoming to Coolidge, Arizona
Gulf Oil Corporation	33	8	Gathering lines from Citronelle, Alabama, field to Mobile
Kaybee Pipe Line Company, Muskegon, Michigan	46	10	Griffith, Indiana to New Buffalo, Michigan
National Co-Operative Refinery Association, Kansas City, Missouri	30	8	Lyons to McPherson, Kansas
Offshore Gathering Company, Houston, Texas	364	20	Offshore line in Gulf of Mexico from Sabine Pass to Mississippi River
Royal Dutch Shell Group and Others	870	30	Marseille, France, to Rotterdam and Antwerp, Holland
Sinclair Pipe Line Company, Independence, Kansas	150	20	Mexia to Houston, Texas. Replacement of existing line
	12	6	North Madill field to Cumberland field terminal, Oklahoma
Socony Mobil Oil Company de Venezuela and Sinclair Oil and Refining Company	211	20	From Silvester field, near Barinas, to Puerto Cabello, Venezuela
Stanmount Pipe Line Company	140	10	Beaver Lake field, North Dakota to Cromer, Manitoba station on Interprovincial Pipe Line
Tecumseh Pipe Line Company	—	20	New line between East Chicago, Indiana, to Cygnet, Ohio
Trans-Border Pipe Line Company	110	—	Skagway, Alaska to Whitehorse, Yukon, Territory
Trans-Prairie Pipe Lines, Ltd., Winnipeg, Manitoba	17	3–6	Lines in Cromer and Virden areas, Manitoba
Union Oil Company, Los Angeles, California	815	—	Considering line from shale oil plant at Rifle, Colorado, to Los Angeles area
	225	12–16	Junction station to San Francisco

PRODUCTS LINES

Name of Company	Miles	Size	Location
Ar-Mex Pipe Line Company, Dallas, Texas	60	8	Coolidge to Phoenix, Arizona
	70	8	Coolidge to Tuscon, Arizona
California-Oregon Pipe Line System, Crescent City, California	103	6	Crescent City, California to Medford, Oregon
Canadian Hydrocarbons, Ltd.	800	6-8	Alberta to Lakehead
Crescent Corporation, Tulsa, Oklahoma (LPG Line)	120	6	Tioga, North Dakota to U. S.-Canadian Border
El Paso Natural Gas Company, El Paso, Texas (LPG Line)	60	10	Farmington to Gallup, New Mexico
Malco Pipe Line, Inc., Roswell, New Mexico	91	6	Prewitt to Albuquerque, New Mexico
	138	6	Artesia to Newman, New Mexico
Phillips Pipe Line Company, Bartlesville, Oklahoma	50	12	Sweeny to Pasadena, Texas, refinery near Houston
Sioux Oil Company	50	6	Newcastle, Wyoming to Rapid City, South Dakota
Texas Eastern Transmission Corporation, Shreveport, Louisiana	1168	16–20	Plans to convert the "Little Inch" line between Beaumont, Texas and Moundsville, West Virginia. New gas facilities to replace this line have been completed but FPC order allowing removal from gas service has been remanded to FPC by a superior court order.
Winnipeg & Central Gas Company, Winnipeg, Manitoba (LPG Line)	210	6	U. S.-Canadian border to Winnipeg (See also Crescent Corporation listing)

GAS LINES

Name of Company	Miles	Size	Location
Alberta Gas Trunkline, Calgary, Alberta	315	6–34	Gas gathering system in Alberta fields to serve proposed Trans Canada Pipe Lines
Andes Pipeline Corporation	500	12	Villamontes, Bolivia, to Yuni, Bolivia, through the Andes Pass, to Antofagasta, Chile
Carolina Natural Gas Corporation	185	2–12	Lines in North and South Carolinas
Cities Service Oil Company, Bartlesville, Oklahoma	70	—	Gas gathering system on the Roberts Ranch, Midland County, Texas
Coastal Transmission Corporation, Dallas, Texas	562	22–26	McAllen, Texas to Baton Rouge, Louisiana
	272	Var.	Gathering lines in Rio Grande Valley, Texas

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**

No Day is FRYDAY

with these Allis-Chalmers MOTORS

● Frying of insulation is impossible under normal conditions with the extra-large cooling surface of Allis-Chalmers rib-type TEFC motors. The result—you expect and get longer motor life.

The engineered partner of A-C motors is Allis-Chalmers control.

Get Complete Information

As a new machinery component or as replacement, specify Allis-Chalmers. Discuss your particular application with your nearby A-C distributor, A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4940

Maintenance engineering

You can arrange to have a Honeywell service engineer visit your plant at regular intervals to inspect, clean, and adjust your instruments and controls. He's factory-trained and field-experienced in keeping good instruments in top operating condition. If an emergency should arise, a phone call will bring a Honeywell service engineer to your plant in a hurry.

Spare parts, in a rush

A Honeywell branch office near you can be your storeroom for standard parts . . . in addition, the Parts Depot in Philadelphia carries a complete stock of all normally needed parts. With Honeywell stocking your spare parts, you save storage and inventory control costs. Most shipments are made within 24 hours after orders are received.

Application engineering

Experienced Honeywell application engineers know your industry and processes. They design *complete* systems of instrumentation, reducing the work of your own engineering staff. From the broad Honeywell line, they recommend instruments that are exactly right for the job. And because Honeywell supplies all types of instruments, recommendations are made without bias. Service engineers will, if needed, help with installation and startup of your system.

Service is the big extra you get with Honeywell instrumentation

Practical service training

The tuition-free Honeywell Training School teaches your instrument technicians the most up-to-date maintenance methods, fits them for the kind of problems they may encounter on the job. Intensive courses range from two to fourteen weeks.

Honeywell offers you far more than instruments. You get service whenever and wherever you need it . . . service that begins when you first decide you need instruments, and continues long after they're installed. This service is always conveniently close at hand, for there are more than 110 Honeywell sales and service centers located strategically throughout the U. S. and Canada.

Prompt, competent service by nearby field specialists is an important plus-value of Honeywell instrumentation. Your local Honeywell sales engineer has all the facts on this service as it relates to your instrumentation needs. Give him a call . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

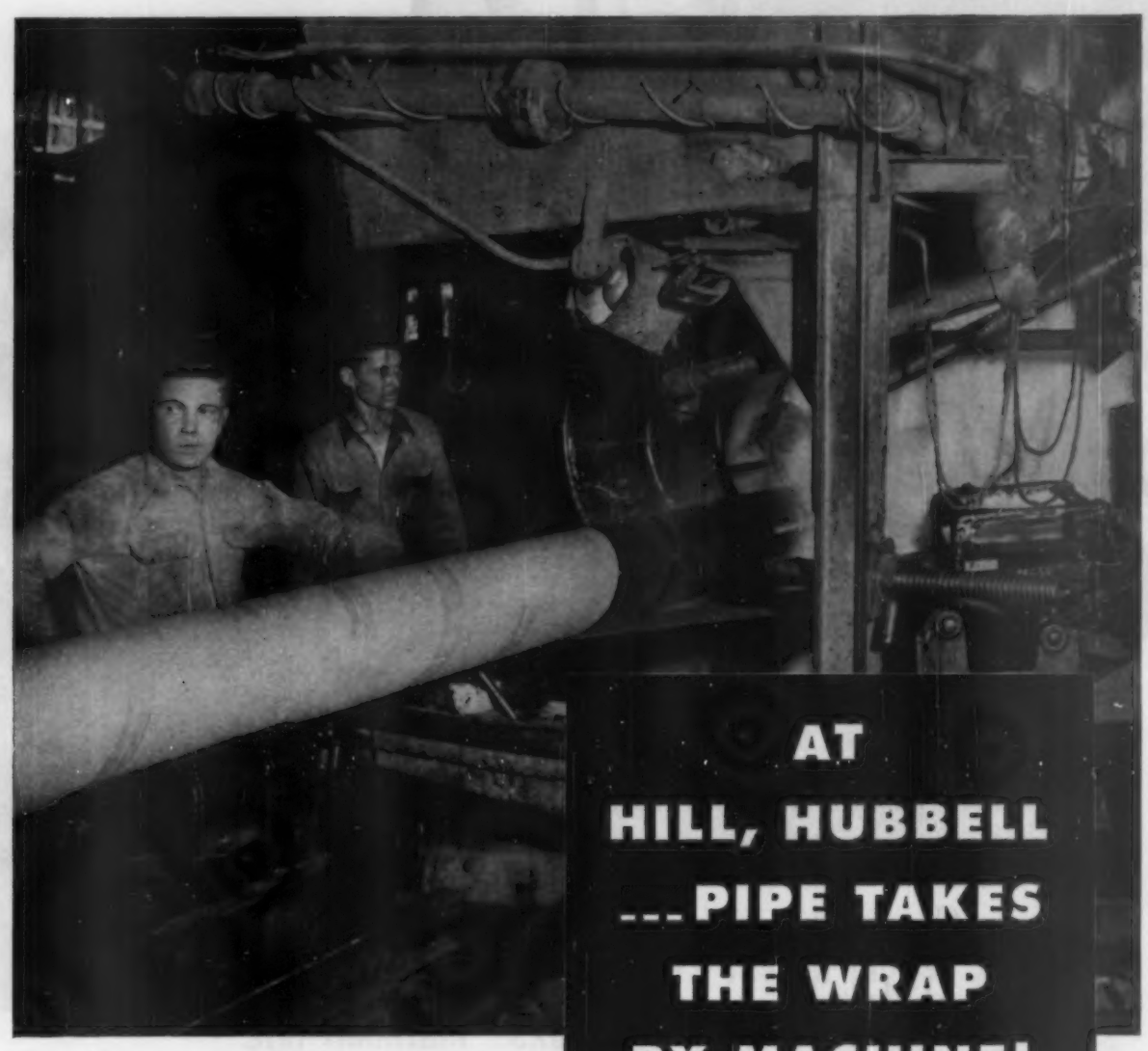
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

GAS LINES (Continued)

Name of Company	Miles	Size	Location
Colorado Interstate Gas Company, Colorado Springs, Colorado	110	6–8	Julesburg area to Denver, Colorado
	307	30	Main line between Idalia, Colorado and Beatrice, Nebraska
	160	26	Lateral between Carr, Colorado and Idalia
	75	26	Lateral between Kit Carson, Colorado and Idalia
	215	20-26	Parallel existing line between Texas and Oklahoma Panhandle gas fields and Kit Carson, Colorado
	34	16	Gathering lines from Keyes field, Oklahoma and Greenwood field, Kansas to new line
El Paso Natural Gas Company	108	4-20	Andrews and Ector counties, Texas
	888	—	Texas, New Mexico, Arizona
Houston Texas Gas & Oil Company, Houston, Texas	961	12–20	Baton Rouge, Louisiana to Miami, Florida, serving Florida area with various laterals
Iroquois Gas Corporation, Buffalo, New York	36	Var.	Gathering and delivery lines in underground storage area in Chautauqua, Cattaraugus and Erie Counties, New York
Lone Star Gas Company, Dallas, Texas	230	30	Cotton County, Oklahoma to Fritch, Texas
	205	24	Snyder, Texas to Cotton-Fritch line
Michigan-Wisconsin Pipe Line, Detroit, Michigan	724	4–24	Loops on system in Missouri, Iowa, Illinois, and Wisconsin
Michigan-Consolidated Gas Company, Detroit, Michigan	25	12	Sparta to Muskegon, Michigan
Midwestern Gas Transmission Company, Houston, Texas	1112	12–24	Main line from U. S.-Canadian Border near Emerson, Manitoba-Noyes, Minnesota to Portland, Tennessee
	648	3–18	Laterals off main line to serve communities in Minnesota, North Dakota, and Wisconsin
Montana-Dakota Utilities Company, Minneapolis, Minnesota	41.8	12	Tioga-Beaver Lodge field in North Dakota to main transmission line
Natural Gas Pipeline Company of America, Chicago, Illinois	350	20–26	Fritch, Texas to Wise County, Texas, through Southwest Oklahoma
	398	36	Beatrice, Nebraska to Joliet, Illinois
	91	30	Loops in Nebraska, Kansas, Oklahoma
	25	—	Gathering line from Quinduno field Roberts County, Texas to a point on its existing system
Nevada Natural Gas Company, Las Vegas, Nevada	114	10	Loop of present system
New York State Natural Gas Corporation, Pittsburgh, Pennsylvania	27	—	Extend existing line from Elk County, Pennsylvania to new gas field in Clearfield, Jefferson, and Indiana Counties, Pennsylvania
Northern Natural Gas Company, Omaha, Nebraska	15	24	Loops on system in Nebraska
	28	24	Ogden to Redfield storage area, Iowa
	168	20	St. Paul-Minneapolis to Duluth, Minnesota and Superior, Wisconsin
	163	10–12	Main lines in South Dakota
	307	Var.	Branch lines in South Dakota, Minnesota, Iowa, and Wisconsin
	100	20–24	Savanna Creek field, Alberta to Alberta-Montana border near Cardston, Alberta
Northern Plains Natural Gas Co. (Subsidiary Northern Natural Gas Co.	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Northwest Utilities, Ltd.	42	—	Bonnie Glen to Edmonton, Alberta
Offshore Gathering Company, Houston, Texas	364	30	Offshore gas line in Gulf of Mexico from Sabine Pass to Mississippi River
Pacific Gas & Electric, San Francisco, California	150	34	Loops on Topock, Arizona to Milpitas, California system
Permian Basin Pipeline Company, Omaha, Nebraska	19	16	Gathering system for 15 West Texas gas fields
Pioneer Natural Gas Company, Amarillo, Texas	261	3–22	New lines, loops, replacements and irrigation feeder lines in the Panhandle and South Plains of Texas
Shenandoah Gas Company, Winchester, Virginia	39	3–8	Middleton, Virginia to Martinsburg, West Virginia
Southern Counties-Southern California Gas Companies, Los Angeles, California	236	30	Topock, Arizona to Newhall, California. A 49-mile section of the line has been contracted, with remainder to be let in August
Tennessee Gas Transmission Company, Houston, Texas	100	—	New gathering lines in Texas and Louisiana
	162	26-30	Loops in Kentucky, Ohio, and Pennsylvania
Texas Eastern Transmission Corporation, Shreveport, Louisiana	422	30	McAllen to Vidor, Texas
	530	30	Loops on system from Texas to New Jersey
	180	Var.	Supply, lateral, and gathering lines
Texas Illinois Natural Gas Pipeline Co.	59	20	Joliet to Volo, Illinois
Trans Canada Pipe Lines, Ltd., Calgary, Alberta	2247	14–24	Alberta area to Toronto, Montreal, and other eastern Canadian areas
Trans-Carolina Pipeline Corporation, Raleigh, North Carolina	840	2–18	New line between Moore, South Carolina, and Monroe, North Carolina, with laterals
Transcontinental Gas Pipe Line Corporation, Houston, Texas	277	30–36	Louisiana, Alabama, Georgia, South Carolina, North Carolina, Mississippi, Virginia, Maryland and Pennsylvania
Union Gas Company of Canada, Chatham, Ontario	180	—	Dawn Storage Field to Hamilton, Ontario
United Natural Gas Company	50	12	Elk County to Jefferson County, Pennsylvania
Virginia Natural Gas Company	153	—	Buckingham to Richmond and Portsmouth, Virginia



AT HILL, HUBBELL ---PIPE TAKES THE WRAP BY MACHINE!

You are looking at one of the reasons Hill, Hubbell is an industry leader in pipe protection. Multiple layers of hot coatings are applied simultaneously as primed pipe is spirally driven through stationary coating and wrapping *machines*—under roof where every factor, including the weather, is controlled!

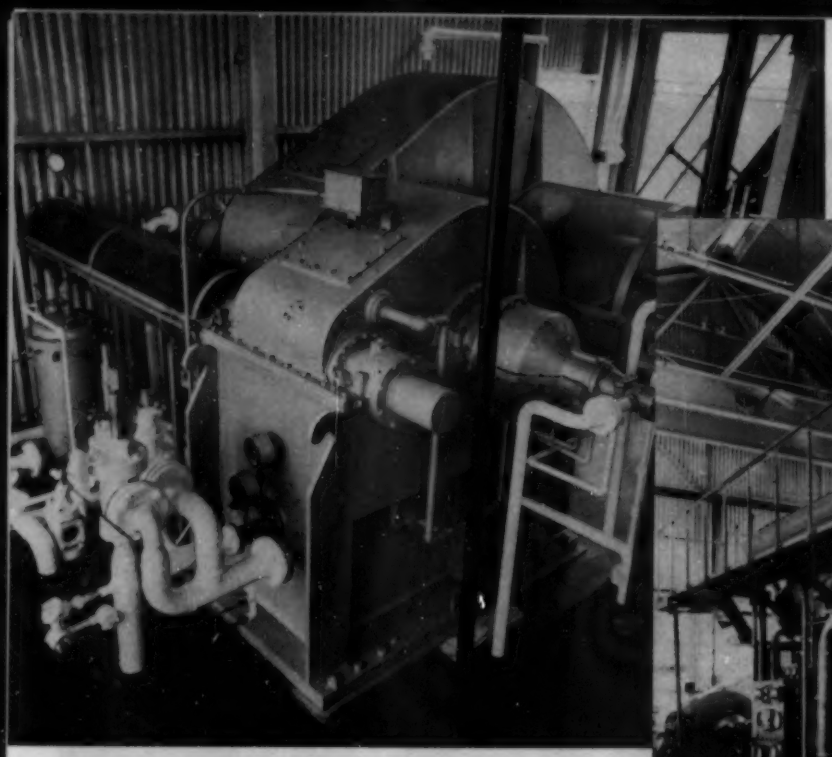
Contrast this precise method with other coating and wrapping systems. As with so many improvements in pipe protection, mill coating and wrapping was originated by Hill, Hubbell and is—

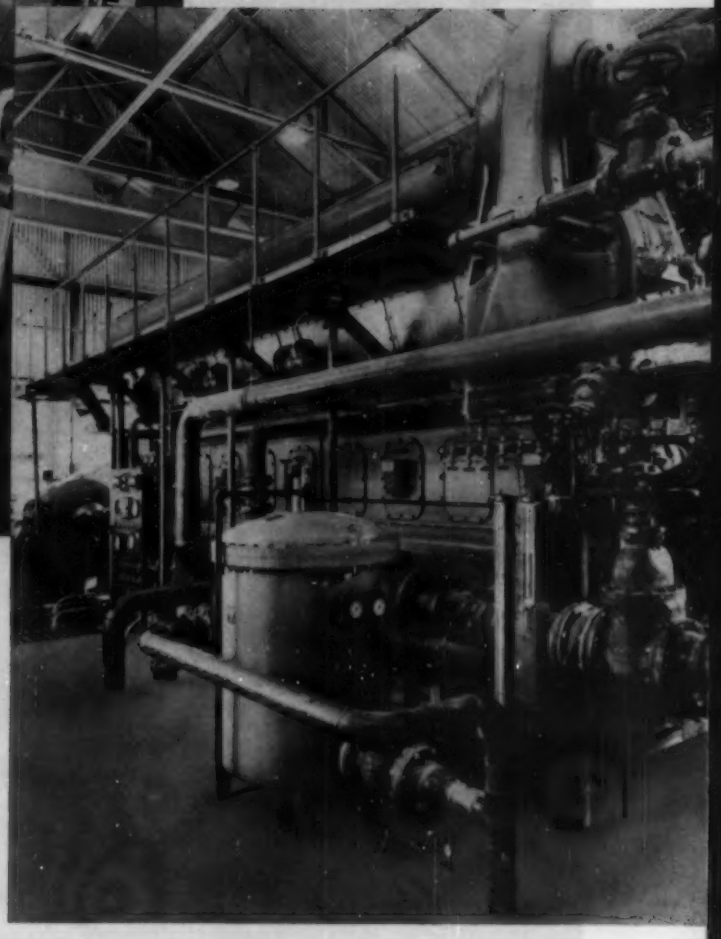
Another "first" pioneered by the first name in pipe protection

FACTORY APPLICATORS OF COATINGS AND WRAPPINGS

HILL·HUBBELL & COMPANY

DIVISION OF GENERAL PAINT CORP. • 3001 MAYFIELD ROAD, CLEVELAND 18, OHIO





"Satellite" pipeline station, remotely controlled, uses Western Gear two-stage high speed drive

REMOTE CONTROL operation from a point many miles away is a notable feature of the isolated Gulf-Interstate Gas Company's gas line pumping station near Stanton, Kentucky. Another modern feature is its two-stage high speed unit especially designed and manufactured by Western Gear, shown at upper left. This "custom-engineered" unit is driven by a Cooper-Bessemer 16-cylinder engine operating on natural gas from the pipeline. The engine speed of 360 RPM is stepped up by the high speed unit with a ratio of 16.8:1 driving the centrifugal compressor at 6,055 RPM. The entire pipeline station can be placed into operation and completely controlled by a telemetering system miles away.

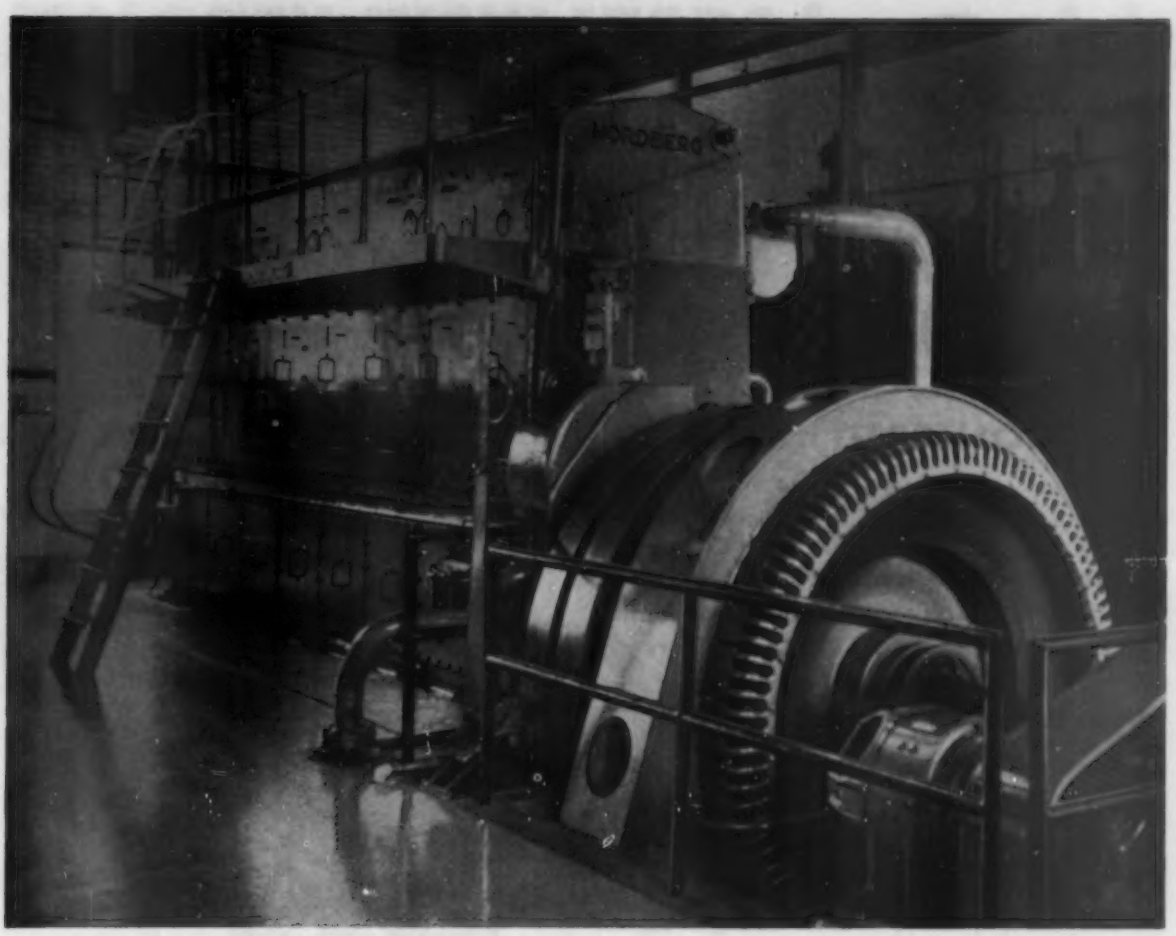
Pipeline experts consider this station one of the most modern and advanced systems of its kind to date. Western Gear's long experience, dating back to 1888, made it the logical choice to design and build the high speed unit so essential to efficient performance of this significant installation. This experience is always available and Western Gear engineers are glad to help solve any problem involving mechanical power transmission equipment for the petroleum industry. Write General Offices, Western Gear Corporation, P.O. Box 182, Lynwood, California.

"The difference is reliability" • Since 1888

9884

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON
REPRESENTATIVES IN PRINCIPAL CITIES

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS



After 30,000 hours Koppers Piston Rings still maintain "excellent" compression

At the Neodesha Municipal Power Plant, Neodesha, Kansas, Koppers Piston Rings are an important part of the 1750 bhp. Nordberg Duafuel Engine illustrated above. After 30,000 hours of operation the pistons on this engine have never been pulled, and compression is still excellent. It is interesting to note that this Nordberg Engine, equipped with Koppers Piston Rings, has been in operation over 98% of the time—and carries about 90% of the plant load.

Koppers has widely experienced engineers and extensive manufacturing facilities which combined can fill the most difficult of piston ring requirements. Next time you are concerned with piston rings or sealing rings, whether in replacement or new installations—in engines large or small—call on Koppers. Never any obligation, of course. For more information, mail coupon.

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • Baltimore, Maryland

This Koppers Division also supplies industry with Fast's Couplings, Aeromaster Fans, Koppers Electrostatic Precipitators and Gas Apparatus.

Engineered Products Sold with Service

AMERICAN HAMMERED *Industrial Piston Rings*

KOPPERS COMPANY, INC., *Piston Ring and Seal Dept.*, 1708 Hamburg Street, Baltimore 3, Md.

Gentlemen: Please send me free 16-page booklet containing full information on Piston Rings.

Name.....

Company.....

Address.....

City.....Zone.....State.....

25TH ANNIVERSARY of MICROWAVE COMMUNICATIONS

...PIONEERED in 1931 by IT&T

Today, all the world-wide technical, manufacturing, installation and operating experience gained by IT&T engineers since the birth of microwave is now available in one great system—

Federal MICROWAVE

A new age of communications was born 25 years ago when IT&T engineers conducted the world's first successful demonstration of microwave . . . across the English Channel.

In the brief span of one generation microwave has spread all over the globe. In North America, the trail was blazed by *Federal* Microwave . . . supplying tens of thousands of channel miles . . . operated by pipelines, power utilities, telephone companies, municipalities, administrations, TV stations and others . . . bringing new speed and dependability to their communications, supervisory and control operations.

Whatever its needs . . . for today or tomorrow . . . industry can look to *Federal* Microwave with confidence, for no other system possesses such a long background of quality and performance ..."*Certified by a World of Research.*"

Scene of the world's first demonstration of the amazing possibilities in microwave communications . . . by IT&T engineers . . . from Calais, France, to Dover, England, in 1931.

Federal

A DIVISION OF IT&T

For full information, write to Dept. H-777

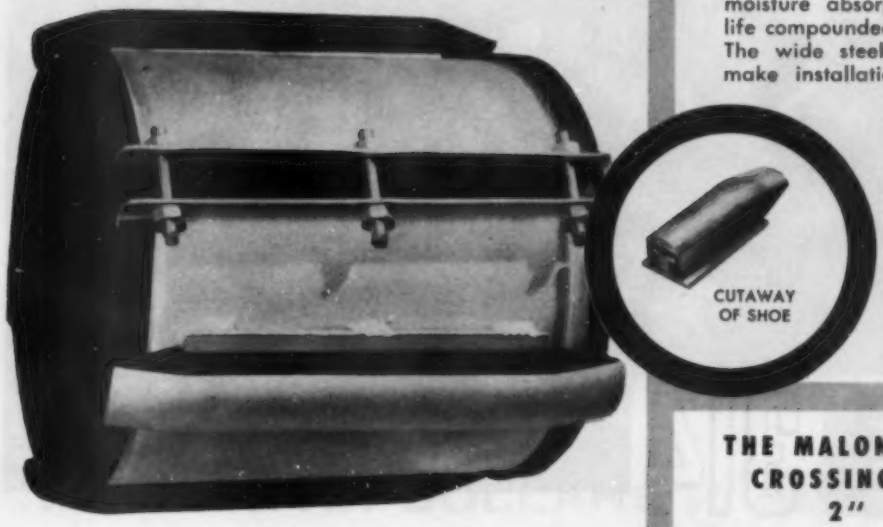
Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
APPARATUS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

MALONEY INSULATORS for any job

LARGE

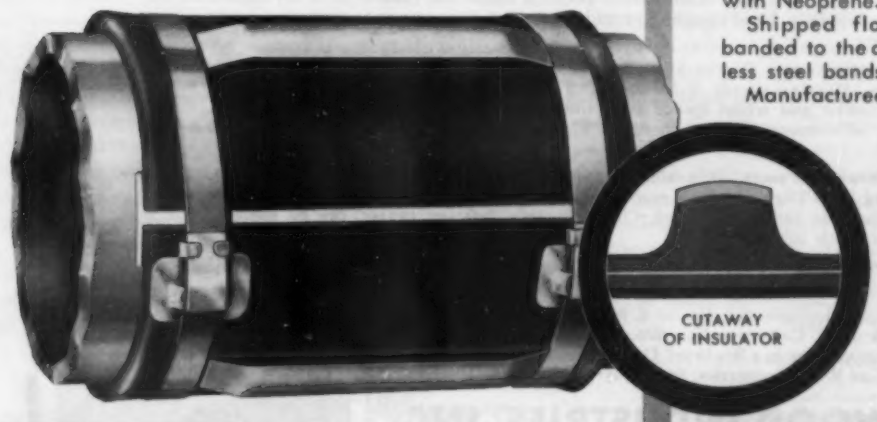


THE MALONEY MODEL 55 CROSSING INSULATOR FOR ALL SIZES OF PIPE

These insulators have superior insulation qualities because of the low moisture absorption and the long life compounded into the Neoprene. The wide steel, sled type runners make installation easy. The extra wide band affords a positive grip.

Bonded metal-to-Neoprene-to-metal, the runner insulates and also permits flexibility to compensate for pipe shifting and acts as a shock absorber to prevent damage due to sudden heavy loads.

or small



THE MALONEY MODEL 56 CROSSING INSULATOR 2" TO 12"

Manufactured with Neoprene, which is vulcanized to steel band core and to the rounded steel runners, there is no place to "short-out" between the casing and the carrier line. The steel core is completely surrounded with Neoprene.

Shipped flat, the Insulator is banded to the carrier pipe with stainless steel bands.

Manufactured in sizes from 2" thru 12", it can be used either on installations where there is only one nominal pipe size difference or on installations having a larger differential.

This is the Insulator designed and manufactured to give you the best job at a competitive price.

SINCE 1932—
PRECISION IN RUBBER—
METAL—PLASTICS

"Something from the Irishman"

F. H. MALONEY *Company*

2301 TEXAS AVE. • FA 3-3161 • HOUSTON

Gar Wood Buckeye 314

DELIVERS MORE DITCH PER DOLLAR!

Make this 4-way comparison and see why...

Compare useable power at the wheel—On a Buckeye 314 *more* of the engine's power is available at the digging wheel. Anti-friction bearings make the difference! They reduce power loss, cut fuel bills. Fluid coupling provides a smooth flow of power, cushions shocks in tough digging.

Compare operating ease—On the 314, all controls are grouped within convenient reach of the operator. Digging speeds, 8 forward and 2 reverse, are easier to select and use. Independent crawler and wheel speeds and positive hydraulic wheel hoist permit faster, more accurate adjustment to meet changing digging conditions. Booster clutches make steering easier.

Compare maintenance costs—Downtime is kept to a minimum. Unit-type construction makes servicing easy. Digging wheel trucks are flush lubricated, sealed against water and dirt, easily adjustable for wear. "Quick Change" rooter bits last longer, can be replaced easier and at a much lower cost.

Compare flexibility to meet job conditions—Only Gar Wood-Buckeye offers a complete choice of factory engineered options to handle every application and digging condition!

The Gar Wood-Buckeye 314 digs to 6 feet deep, 16 to 30 inches wide in 2-inch steps. Call your Gar Wood-Buckeye dealer and see how much *more* you get in a Buckeye! Or, write to: Customer Service Department, Gar Wood Industries, Inc., Wayne, Michigan.

GAR WOOD INDUSTRIES, INC.

Wayne, Michigan • Findlay, Ohio

Plants in Wayne and Ypsilanti, Mich.; Findlay, Ohio; Mattoon, Ill.; Richmond, Calif.

WORLD'S LARGEST DITCHER!

Gar Wood-Buckeye model 330 digs 600 cubic yards per hour, cuts a ditch 11¼ feet deep and 5⅓ feet wide. Write for pictures and specifications!

Gar Wood Excavators

Gar Wood-Buckeye Ditchers

Gar Wood Tractor Equipment

Gar Wood Winches

Gar Wood—St. Paul Mixers & Bodies

Sweep up EXTRA DOLLARS *off your tank bottoms*

You may save $1,000 a year controlling sludge this easy way

Don't let BS&W rob you of profits that should—and easily can—be yours.

It doesn't cost money to keep crude oil tanks clean by flipping a switch. It *pays.* Careful field tests, by a large pipe line company, show a direct, traceable saving of *$1,000 per tank per year.*

This figure indicates what you can save just by eliminating the costly job of cleaning out bottom sediment.

Tanks work harder, too

In addition, your tankage works at full efficiency when you need it. You add as much as 12% more tank capacity, without adding a single tank. You need never disrupt normal dispatching because tanks are "down" for cleaning.

You eliminate settling of refinable oil and wax. This can run as high as 4,000 barrels, in a 120-foot tank with 2-foot level of sludge. And you minimize the chances of corrosive sludge chewing holes around the tank bottom.

To get these savings, more than 50 independent pipe line companies and 35 leading producers and refiners choose LIGHTNIN Mixers for crude oil sediment control.

Simplest maintenance possible

You save more with LIGHTNINs, because maintenance is extra-easy. LIGHTNINs are built so they can *never* get out of alignment. Repacking is fast and simple, even with the tank full.

And for even bigger savings on upkeep, you can get the LIGHTNIN cartridge-type rotary seal that ends stuffing-box repacking forever.

You can get LIGHTNINs in a full range of sizes, from 1 to 25 HP, easily installed on old or new tanks.

Wouldn't you like to have specific facts on what *you'll* save with LIGHTNIN Mixers on your tanks? Your LIGHTNIN representative can give you these facts. You'll find him listed in Composite Catalog. Or write us today.

Lightnin' Mixers

MIXCO fluid mixing specialists

Left: **FASTER SERVICING.** You can repack a LIGHTNIN stuffing box from outside a full tank, without losing a pint of liquid. Shutoff device is out in the open, easy to get at. ***Right:*** **NO REPACKING** with this cartridge seal (optional on LIGHTNIN Mixers). It takes the place of a stuffing box; stops leakage; runs for years without adjustment; comes out in one piece for easy, rapid replacement if ever necessary.

Get these helpful bulletins on BS&W control and LIGHTNIN Mixers. Check, tear out and mail to us today with your name and company address. Free—no obligation.

- ☐ B-503 BS&W Control with LIGHTNIN Mixers
- ☐ B-104 Side entering mixers. 1 to 25 HP
- ☐ B-107 Data sheet for figuring mixer requirements
- ☐ B-110 Condensed catalog describing LIGHTNIN Mixers—all types
- ☐ B-111 LIGHTNIN rotary mechanical seals for extra-low-cost mixing

MIXING EQUIPMENT Co., Inc., 127-h Mt. Read Blvd., Rochester11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.

For YOU...

AN IMPORTANT MESSAGE!

BRAZOS EQUIPMENT RENTAL COMPANY

★

Now The World's Largest
Pipeline Construction Equipment
Rental Firm Supplying Contractors

NEW OWNERSHIP, MANAGEMENT, POLICIES

The multi-million-dollar investment in the world's largest and most complete stock of equipment for pipeline construction was acquired July 2nd, 1956, by Brazos Equipment Rental Company from Anderson Bros. Corporation, formerly the world's biggest pipeline contractor. This tremendous inventory of equipment is now under new ownership, new management and new policies which you will like.

EQUIPMENT RENTED TO CONTRACTORS

Brazos Equipment Rental Company offers this late-model equipment — of every type needed for pipeline laying, land clearing, road building and other heavy construction — to pipeline contractors for rental . . . or on a rental-purchase, sale, or trade arrangement, as you prefer.

EQUIPMENT NOW IN SEVEN STATES

Now located in Texas, Montana, Wyoming, Minnesota, Louisiana, Ohio and North Carolina; this modern equipment can be moved to your jobs anywhere in the United States, Canada or Mexico.

ALL TYPES OF EQUIPMENT AVAILABLE

Machinery of every type . . . from generator units of 10 to 1000 k.w., up to complete spreads of pipeline construction . . . can now be rented by contractors on a profitable basis. With more than 85 crawler tractors for various applications to choose from, and the largest stock of winches, welders and other pipeline machinery ever assembled — spreads of any magnitude, even difficult river crossings, are now within every contractor's bidding range!

You name it — we probably have it in one of our yards!

BRAZOS EQUIPMENT RENTAL COMPANY

Ask for DON SHARP, *General Manager*

Phone: JAckson 8-5475

After 6:00 P.M., or on Saturday, Sunday and Holidays: Phone OVerland 2-7347, or JAckson 2-2186

3200 Wheeler Street or P. O. Box 8157, Houston, Texas

Affiliate Companies:

BRAZOS ENGINEERING COMPANY, INC.

PAUL E. McDANIEL, INCORPORATED

Pioneering the World's Largest

★ 20 Ft. FAN
★ 3750 H.P.
★ COOLER . . 30 Ft. LONG
. . 26 Ft. WIDE

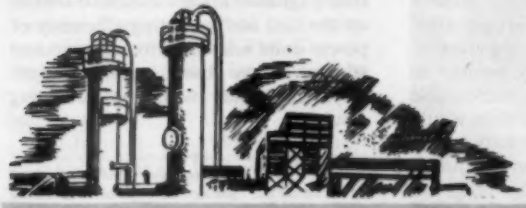
SINGLE AIR-COOLED HEAT EXCHANGER

Smithco Engineering Inc. is proud to have been a part of the remarkable satellite station recently installed by Gulf Interstate Gas Company in Stanton, Kentucky.

Smithco Engineering developed a unique design for this application which has proven to be completely reliable and trouble-free.

For outstanding quality and reliability always look to Smithco.

THE *FIRST* OF ITS KIND!



Plant & Offices — Tulsa, Oklahoma

P. O. Box 3171

Representatives in the Petroleum Industry

SMITHCO
Engineering Inc.

The Satellite Station that actually operates unattended about half the time. The station shuts itself down in case of trouble.

Gulf Interstate's Stanton Station is remotely controlled and entirely unattended, saves on operating cost, provides more effective control, and is the . . .

First Automatic

PRIOR to 1954, the suggestion that an interstate natural gas pipe line might be completely powered by semi-automatic compressor stations, operated on a one-man-shift basis, aroused considerable curiosity and interest in the industry. Often this interest was tempered by skepticism, and the subject, generally, was largely academic to pipe line companies fully staffed and operating in the conventional manner. The idea of a mainline compressor station operating continuously unattended and remotely controlled, received little serious consideration and a wide variety of objections was interposed as to why such a station could not be practicable.

On November 1, 1954, Gulf Interstate Gas Company made its first deliveries of natural gas through its 1160-mile system to United Fuel Gas Company, its sole customer for the transportation service. Power for this service was provided by five compressor stations at 8000-hp each, operated semi-automatically with only one operator per shift per station. Today, after almost two years of continuous operation, the record of these semi-automatic compressor stations is unusually good.

Shortly after the original system was placed in service, Gulf Interstate engineers began design work aimed at applying the latest methods in controls engineering to a natural gas compressor station, with the ultimate result to be a completely unattended "satellite" station, remotely controlled from an upstream compressor station 80 miles distant. Today that station is a reality, with more than six months of operating history behind it — the Stanton Compressor Station located near Stanton, Kentucky.

Development of the Stanton Idea

Radical departures from conventional design and engineering practices present serious problems to a company whose existence depends on economical and reliable service to the public. The risk to investment can be a powerful deterrent to experiment. Gulf Interstate, however, was favored by several circumstances in getting Stanton from the drawing board into operation.

First, the labor-saving operation of the existing station clearly pointed to the feasibility of remote control, and the design of the Stanton Station would provide an excellent opportunity for experiment as to the direction any future major station construction programs should take.

Second, the proposed station, to be located between the Clementsville Compressor Station and the delivery points at Means and Leach, Kentucky, would afford greater flexibility in delivery pressures as peak demands might be made by the customer.

Third, the station was to be designed so that if the automatic features should prove impracticable, it could be converted easily to the one-man-per-shift operation as a permanent installation.

Four, failing the procurement of a certificate for operation as a permanent installation, (still assuming the automatic features to be impracticable), most of equipment could be applied to a conventional station, so that net loss of the venture would be greatly reduced.

Design

Having received provisional approval from United Fuel Gas Company to proceed with design work, Gulf Interstate engineers made exhaustive studies on the cost and operating efficiency of power units adaptable to the proposed station. Three basic station designs were examined, with the following results:

	Operating cost per hp year	Fuel cost	Thermal efficiency
Engine-driven Centrifugal	11.8	8.1	41 %
Angle reciprocating	13.9	9.4	35.2%
Gas turbine centrifugal	14.5	12.9	25.5%

Pusn of the button starts compressor station 80 miles distant. R. V. Lambert, Gulf Interstate section superintendent, pushes a button at the Clementsville, Kentucky, station to start Stanton station. From control board operator can start and stop the distant station and control discharge pressure.

Control panel at the satellite station. Since the station began remote automatic operations on March 27 there have been no false shut downs.

Compressor Station

All things considered, the engine-driven centrifugal was selected as the logical power-compressor unit for the Stanton Station.

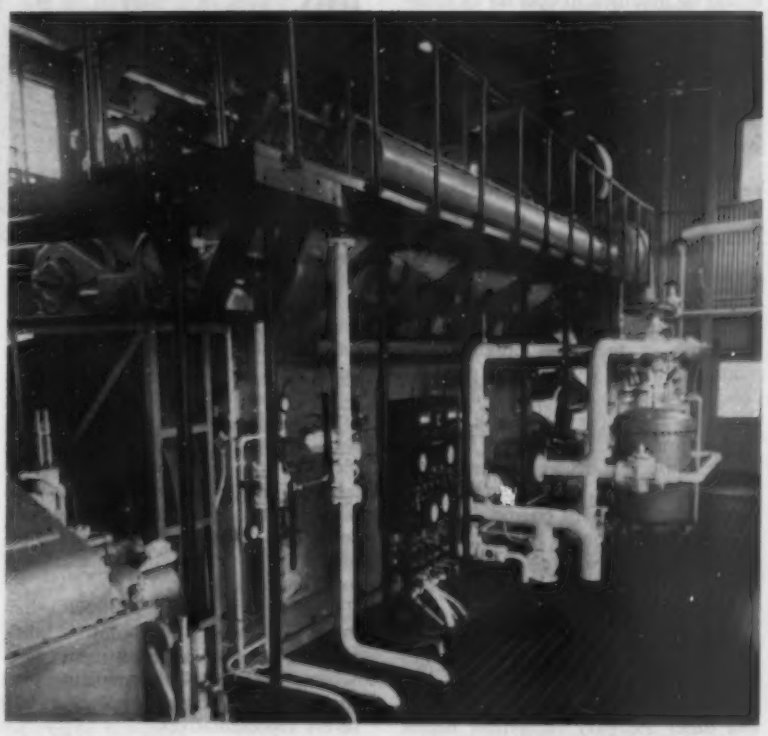
Various controls manufacturers were consulted before selection of control equipment was made, and many of the problems in the application of controls were resolved jointly by company personnel and manufacturers' engineering representatives.

The entire station design program was necessarily governed by one principle — unattended operation must be achieved, safely and reliably, at a lower cost than could be attained by conventional operation.

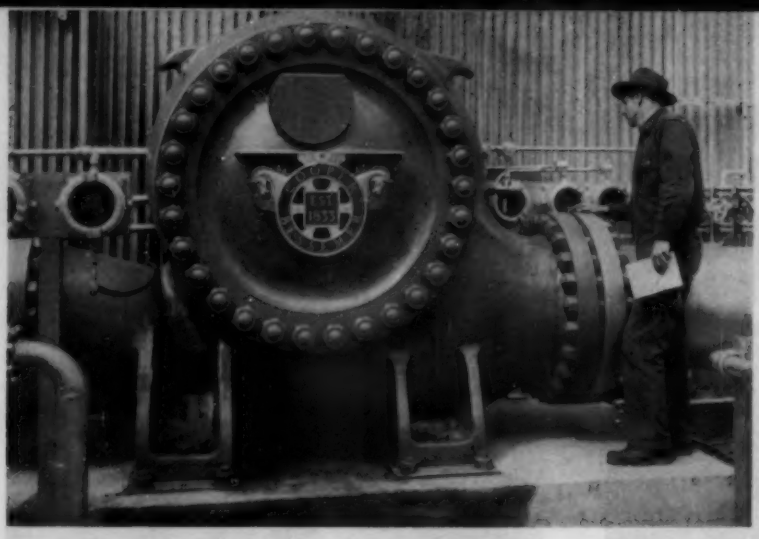
FPC Application

When the proposed station had progressed to the point where cost estimates could be made accurately, United Fuel Gas Company agreed to the construction program, and The Cooper-Bessemer Corporation, suppliers of the power unit, began manufacture of the equipment.

On January 10, 1955, Gulf Interstate Gas Company filed an application with the Federal Power Commission for a certificate of convenience and necessity authorizing the construction of the experimental compressor station at Stanton, Kentucky. Estimated cost of the construction was fixed at $730,000.

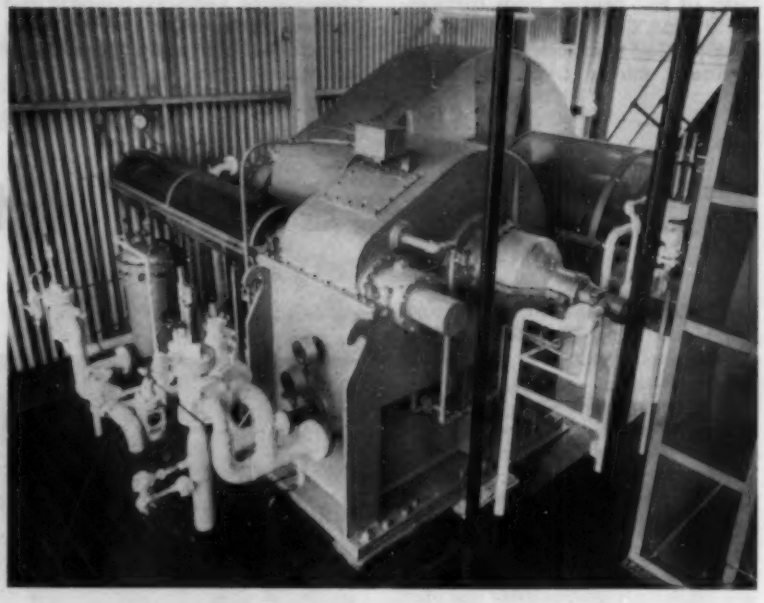


3500-hp reciprocating engine that drives the centrifugal compressor gives thermal efficiency of 41%. In the start up the engine purges, starts, warms up before taking load from the line.



The centrifugal compressor on the outside of the building has a 29-in. impeller wheel and a ½-in. diffuser width.

Speed increaser for the centrifugal compressor. Gear is two-stage double helical; the ratio is 15.56. The rectangular box on top of the gear case is a vibration detector. In case of surge and excessive vibration it will shut the station down.



On April 29, the Federal Power Commission issued the certificate requested, authorizing the construction of a single engine 3500-hp compressor station, to be operated as an unattended "satellite" station, controlled by personnel at the Clementsville Compressor Station 80 miles distant. The certificate was granted for operation during a test period not to exceed 15 months from the date of engine shipment. At the conclusion of this period the station would either be approved as a permanent installation operating unattended, would be modified to operate as existing company stations were operated, or would be removed entirely in a salvage operation.

With this "go-ahead" from the FPC, final construction plans were prepared for contract bids.

On June 15, 1955, a contract was awarded for construction of the station and early in July men and equipment moved on the job site.

Construction

Excavation for the main engine building began on July 12, 1955. The first pour of the main building was made on August 9, when 262 yards of concrete were poured. By October 19, the main and supervisory buildings of steel frame and corrugated sheeting construction, had been constructed and the engine block was prepared for erection of the main engine. The engine was placed on its block on October 21, and by November 20 the engine, gear assembly, and compressor were set. REA electrical power was tied in, and a water line was run from the Red River, approximately two miles from the station site.

By December 15 controls, operators and other auxiliary equipment necessary for local operation had been installed, and the engine was started for the first time. From December 15 to 20, the engine was started and run several times, for test and adjustment purposes only.

On December 21 the engine-compressor unit was put on line, operating locally and manually, pending completion of the control equipment installation. Thereafter, while controls were being put in and tested, the engine and compressor were operated intermittently, with all operation manual and local until March 27, 1956.

By January 20 the contractor had moved off the job. The controls work and engine tests and adjustments were accomplished by Gulf Interstate personnel working closely with manufacturers' representatives.

In the construction of the Stanton Station, 590 yards of concrete were poured, 32,000 in. of welding were done, and 56,000 man-hours were worked by contractor personnel.

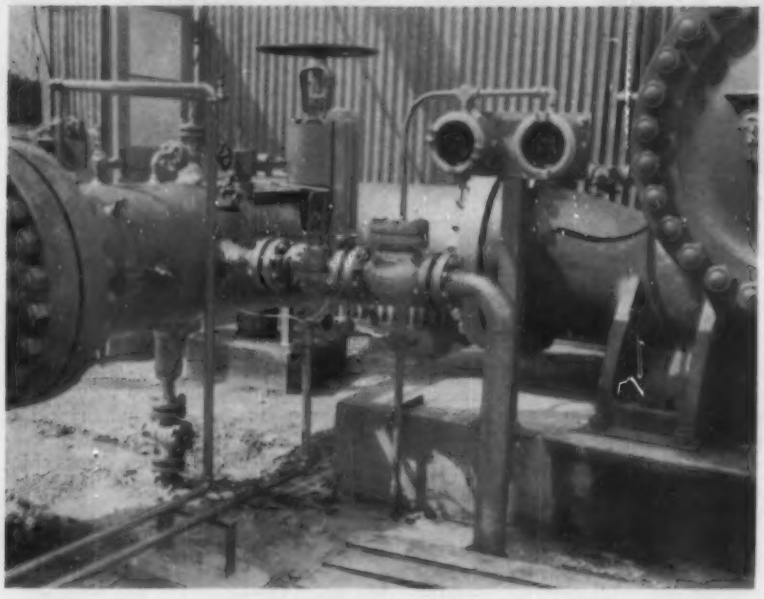
Equipment

Heart of the Stanton Station is the engine-compressor unit. After Gulf Interstate decided on the reciprocating engine driving a centrifugal compressor through a geared speed increaser, Cooper-Bessemer Corporation agreed to construct the unit.

A 16-cylinder, 4-cycle reciprocating engine, rated at 3500-hp was selected as the power unit. This engine is spark-ignited, supercharged, and utilizes turbo-cooling on manifold intake air, permitting increased horsepower delivery without a high heat load on the engine. The engine consumes 6000 Btu of fuel per brake horsepower hour. Jacket water is coil-cooled by a single fan

Relief valves on station suction and discharge.

Blow down valve. On start up purge valve opens and this valve vents. When the engine is stopped blow-down valve vents the compressor.



driven off the main engine through a fluid drive coupling with an automatic governor controlling fan shaft speed. Other auxiliary equipment, such as water and lube oil pumps, and seal and gear oil pumps, are driven directly by the main engine.

A speed increaser[1] is interposed between the engine and the compressor. This gear is a 2-stage, double helical, separate helix articulated type, and on a gear ratio of 15.26, increases rpm's from 360 at the engine to 5500 into the compressor.

Both engine and gear train are situated inside the main engine building. The vertical centrifugal compressor, with a 29-in. impeller wheel and a ½-in. diffuser width, is located on a block outside and immediately adjacent to the main engine building.

Nerve center of Stanton Station is the controls instrumentation with the accompanying recording devices, which permit the operator at the master station to control effectively the satellite station.

These controls[2] perform two main types of functions:

(1) Normal operational control from the remote point, and

(2) Automatic shutdown or alarm sequences.

In normal operation, the operator at Clementsville can start the engine, set the discharge pressure control, and stop the engine remotely.

The automatic safety controls, of which there are 52, fall into three classifications:

(1) Alarm.
(2) Shutdown-restart, and
(3) Shutdown-lockout.

The alarm devices give visual or audible warning of a condition that, in itself, is not sufficiently grave to shut down the engine or the station.

The shutdown-restart controls govern situations serious enough to shut down the engine, but not serious enough to preclude a restart to determine whether the condition that caused the shutdown has been removed.

The shutdown-lockout prevents the engine from being started until the serious damage or failure that caused the lockout has been corrected.

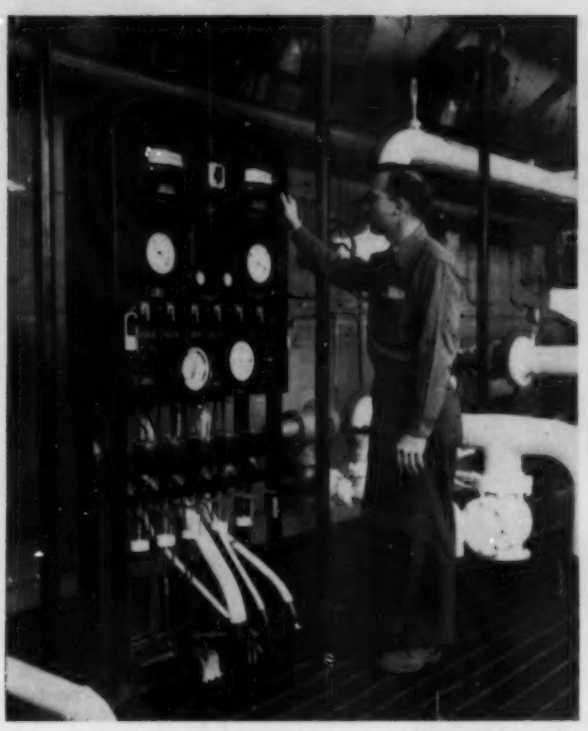
All equipment is "fail-safe" so that loss of power or equipment breakdown will give the alarm or shutdown required. Electrical controls and panels are housed in an annex adjacent to the main engine building.

Fire protection at Stanton is provided by fixed automatic CO_2 system actuated by three different detection devices. The first, a sensory element operated by "seeing" light rays within a certain wave length range, sounds an alarm to summon station personnel. The second alarm device is a rate of temperature change unit, and the third is a high temperature detector. Either or both of the second and third systems will shut down the engine, close the side gates, vent yard and engine piping, and turn on the CO_2 system in the engine building.

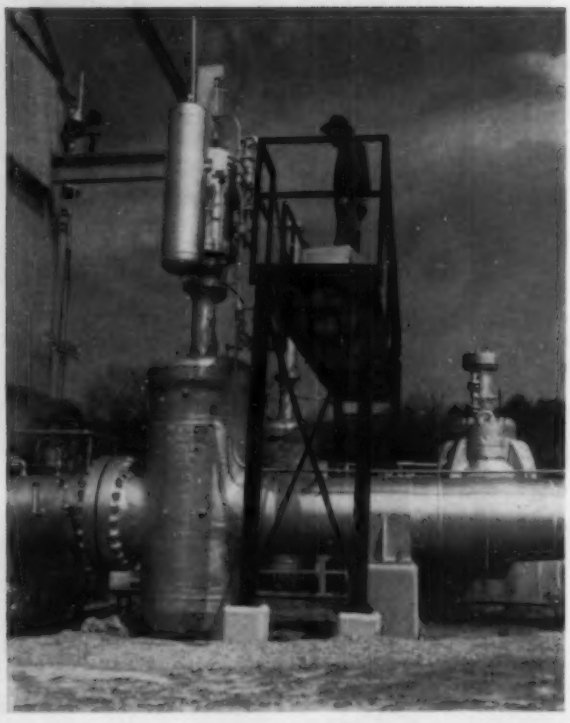
A continuous gas analyzer samples atmosphere around potential danger areas, and will sound an alarm if gas is present. The section superintendent and chief mechanic of the station live in company houses on the station pro-

[1]Manufactured by Western Gear Works.

[2]Manufactured by Union Switch and Signal Company.



Automatic control panel for engine. Bob Smith, Gulf Interstate engineer, is reading cylinder and exhaust temperatures. Note padlock at left, which locks the engine on automatic operation.



Suction and discharge valves open and close in a matter of seconds, being controlled remotely.

per, and thus are always available to respond to any trouble indications.

Power for Stanton is supplied by REA facilities, with a generator unit to pick up automatically the power load in case of line failure. Should the emergency generator fail to function, power is sustained by batteries.

For the remote operator to control the Stanton Station effectively, he must have a continuous channel of information fed to him. In addition to check-back responses, the following information is telemetered to Clementsville, sequentially, over a single line:

(1) **Suction pressure** — telemetered when change occurs plus or minus 2½ psi.

(2) **Discharge pressure**—telemetered when change occurs plus or minus 2½ psi.

(3) **Starting air pressure** — telemetered when change occurs plus or minus 2½ psi.

(4) **Engine rpm**—telemetered when change occurs plus or minus 5 rpm.

(5) **Setting of discharge controller**—the setting of the discharge pressure index point can be made either at Stanton or Clementsville, and the location of the set point is telemetered to Clementsville.

Sequence of Events, Remote Control

All controls installed at Stanton were built to permit operation of the station either remotely or locally.

To put Stanton in operation remotely, the operator at Clementsville sets the discharge pressure controller on the desired point, and presses the *Start* button. The first response is an automatic check of all control equipment at Stanton. If all controls are in proper position and working order, the startup sequence begins. The compressor is purged through a bypass around the suction loading gate, and the engine starting circuit is energized. At this point engine auxiliaries are placed in service automatically. Only if all auxiliary equipment is functioning properly will the main engine actually start.

After start, the engine idles, rapidly accelerates through a critical speed range, the compressor case is brought to line pressure, and the discharge and suction loading gate valve are opened. The engine is now partially loaded for a warm-up period. After warmup is complete the discharge pressure is raised to the discharge controller setting and the unit is fully loaded and on line. As the engine comes on line, it attains and holds the speed requested at the set point. As additional changes in discharge pressure are required, they may be effected by moving the set point to actuate the electronic discharge controller.

Stopping the engine from Clementsville is done by pressing the *Stop* button, which performs these functions 80 miles away:

Main fuel gas valve is closed automatically.

Safety fuel valve is closed.

Line suction and discharge valves are closed.

Ignition system cuts off, stopping engine.

Blowdown valve opens, venting the compressor.

When the engine is down, the compressor suction, discharge, and purge valves are closed, and the blowdown valve is open.

Automatic safety devices will immediately shutdown the station, which remains down until corrections are made, under the following circumstances:

1. **Break in the pipe line**
2. **Low suction pressure**
3. **Fire in main or supervisory building**
4. **High compressor, engine, gear, piping, or fan vibration**
5. **Low remote control shutdown air pressure**

The following circumstances will shut down the engine immediately with permissive restart:

Engine overspeed
Low engine oil pressure
Low gear oil pressure
Low turbo oil pressure
Low compressor oil pressure
Low seal oil level
Low seal oil drain level
Low gear oil temperature
Low engine oil temperature
High discharge pressure
High gear oil pressure
High engine oil pressure
High engine oil temperature
High gear oil temperature
High discharge gas temperature
High thrust bearing temperature
High seal oil drain level
High compressor case temperature
High starting air temperature
High jacket water temperature

An alarm will sound, but the unit will continue operating, in event of any one of the following:

1. **Fire at, or loss of, fuel gas heater**
2. **Low level, jacket water surge tank**
3. **Low level, oil cooling water surge tank**
4. **Low starting air pressure**
5. **Low instrument air pressure**
6. **High centrifuge oil level**
7. **Gas analyzer leak detection**
8. **Fire-detection equipment failure**
9. **High engine oil heater temperature**
10. **High gear oil heater temperature**
11. **Low oil level, engine crank-case or gear-case**
12. **Loss of water pump seals**
13. **High differential across seal oil filters**
14. **High seal oil level**
15. **Seal oil below control level**

In addition to the above, alarm will sound for failure of a-c, d-c, or REA power, gas surge in the compressor, failure in the communications circuit, or discharge pressure at variance by 5 psi or more from that of the set point.

Operational History

Through June 30, 1956, Stanton had operated 4100 hours of which 1709 were unattended. From December 21, 1955, to March 27, 1956, the station was onstream being operated locally, manually as well as automatically. Remote operation began March 27. The day operator was taken off shift on May 21. The 4:00-12:00 shift was discontinued June 5, and the last shift operator was removed from the station on June 16. Since that date, the Stanton Compressor Station has been operated automatically, unattended and remotely controlled from Clementsville. No false shutdowns have occurred since the engine went into operation that have not been man made.

Unplanned engine shutdowns, all for minor repairs or adjustments, have amounted to only 9½ hours of down time since March 27 of this year.

The station has been successful operationally as well as from a design standpoint. The increased flexibility in delivery pressures as well as the capacity for increased peak deliveries for short periods have been advantageous. Peak engine capacity is in excess of 500,000,000 cu ft per day at a discharge pressure of 935 psi. On a 375,000,000 cu ft per day rate, with the engine operating at 327 rpm-3500 hp, the centrifugal compressor operates at an 83 per cent efficiency factor. Mechanical loss through the compressor is 1 per cent and through the gear train 2.5 per cent.

A number of tests of compressor efficiency have been made under different operating conditions. Results of these tests have been satisfactory and indicate both engine and compressor performance up to expectations.

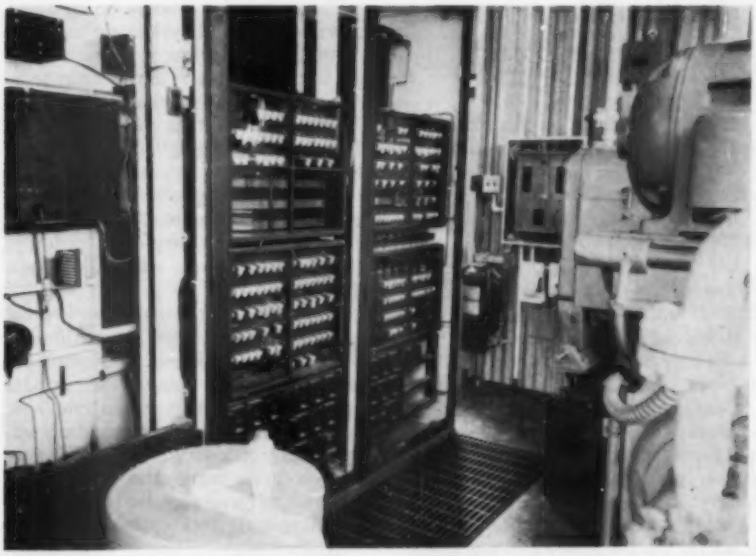
In June, 1956, the Federal Power Commission authorized Gulf Interstate to make Stanton a permanent part of its operating facilities, removing it from the experimental classification.

Future Station Construction

The successful operation of the Stanton Compressor Station, remote-controlled and unattended, has set the pattern for any future compressor stations the company may build in its projected expansion program. The same principles of control that permit Stanton to function are also applicable to multi-engine stations that may be built at the present intermediate locations on the system.

The advantages of operating compressor stations from a central dispatching point are today much more clearly defined as a result of the experimental station at Stanton. An estimated 10-15 per cent savings in operating cost, more effective control over line and delivery conditions, proven dependability and safety, are all substantial reasons for going ahead with the fully automatic compressor station.

Undoubtedly there will be further improvements and refinements in future stations over the present station at Stanton, but the basic design will definitely establish the pattern for Gulf Interstate Gas Company expansions. ★ ★ ★



Back of the control panel shows railroad type switch gear which controls the function of the station. At the left is gas detection equipment, which will flood the pipe trenches with carbon dioxide when leaks occur.

MODERN DESIGN OF OIL PIPE LINES

Fritz Karge
Consulting Engineer

Heat Loss Calculations

The application of the K factor to the problem of determining the temperature drop along a flowing oil line is made easy by T. T. Gill's graph (Graph 3). The graph is based on the following mathematical considerations:

Log — hyperbolic logarithm
$\log_{10}$ — common logarithm
t_1 — difference between initial temperature of oil and atmospheric temperature. It is entirely satisfactory to use in California a minimum air temperature for winter conditions of 50 F, except, as noted before, in high altitudes, for which 40 F is safer.
t_2 — difference in final oil temperature and atmospheric temperature at some distance down the line.
t_m — mean difference between oil temperature and ground temperature.
C — average specific heat of oil, assumed on graph to be 0.5.
s — average specific gravity of oil, assumed on graph to be 0.94.
Q — flow rate, bbl per hr.
K — heat transfer coefficient, oil to atmosphere, 2 ft cover.
D — OD of pipe, in.
X — length of line, miles.
W — weight of bbl of water.

Btu loss from oil equals:

$$W\ s\ C\ Q\ (t_1 - t_2) = 350 \times .94 \times .5\ Q(t_1 - t_2) = 163\ Q\ (t_1 - t_2) \quad . \quad (1)$$

Btu loss also equals the outside surface area of the pipe for the length under consideration times the mean temperature difference times the heat transfer coefficient K: $\text{Pi} \frac{D}{12} \times 5280\ t_m\ K$

$$t_m \text{ (by Grashof formula} = \frac{t_1 - t_2}{\text{Log}\frac{t_1}{t_2}}$$

Btu loss equals:

$$3.14 \frac{D}{12} \times 5280 \frac{t_1 - t_2}{\text{Log}\frac{t_1}{t_2}} K =$$

$$1370\ D \times \frac{t_1 - t_2}{\text{Log}\frac{t_1}{t_2}} K \quad . \quad (2)$$

Equating (1) and (2):

$$163\ Q\ (t_1 - t_2) = 1370\ D \times \frac{t_1 - t_2}{\text{Log}\frac{t_1}{t_2}} K$$

$$\text{Log}\frac{t_1}{t_2} = \frac{1370\ D \times K}{163 \times Q} = \frac{8.4\ D \times K}{Q}$$

Transposing to common logarithms:

$$\text{Log}_{10}\frac{t_1}{t_2} = \frac{3.6\ D \times K}{Q}$$

The graph is based on this equation, and an example illustrates its use:

"Q" will be the maximum flow rate for which the pipe is to be designed.

The proper value for "K" was previously discussed.

For "D" choose 2 or 3 different diameters and carry the calculations through to the pressure drop.

How long shall we made "X"? If the line is only 3 or 4 miles long, make X equal to its overall length.

Long lines should be divided into sections. Then calculate the temperature drop and the pressure drop in each section on the basis of the viscosity pertaining to the mean temperature of the oil in the sections. Add the pressure drops for the successive sections to obtain the pumping pressure.

It is well to analyze mathematically the effect upon the calculated pumping pressure of dividing the pipe line into unequal sections of approximately equal temperature drops, equal successive increases in viscosity, or equal pressure drops.

For most purposes, sections of 2 to 4 miles length will give a result very little different from that obtained by making each section as short as one mile. The engineer should keep in mind that he might have to increase K where the line will pass through long stretches of very wet ground.

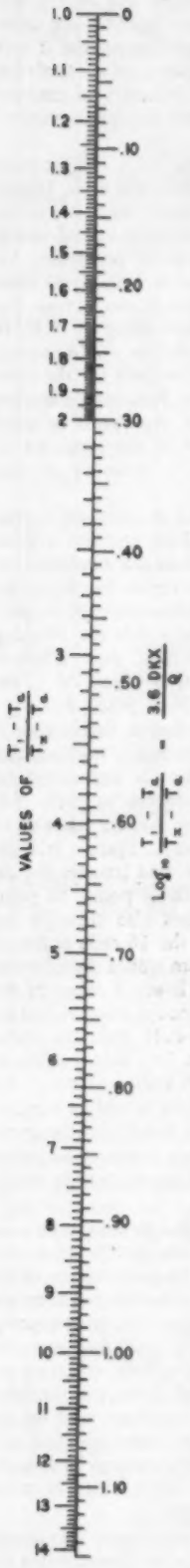
Inspection of the heat loss formula shows that for the same flow rate a larger pipe loses heat faster. The larger line, however, for the same pressure drop per unit distance carries so much more oil that the temperature gradient will be flatter.

Design Calculations

The calculations should be arranged in an orderly and systematic manner. Plotting the temperature gradient along the line, the viscosity at the mean temperature of the successive sections, and the progressive sums of the pressure drops against the length of the line, will bring to light irregularities in the calculations. The logarithmic mean temperature should be used for determining the mean viscosity of a section if the temperature drop is more than 40 F.

As previously stated, the flow in most heavy, heated oil lines passes through the so-called "unsteady" region between the upper and lower critical limits. Let us briefly investigate how much the calculated pressure drop will increase by following the turbulent flow friction factor curve to the lower critical limit, as recommended by many but not all investigators.

Assuming a pipe line of 12 in. diameter and a flow rate of 2000 bbl per hr, Santa Maria Valley crude, specific gravity 0.95.



Based on Formula:

$$\text{Log}_{10}\frac{t_1}{t_a} = \text{Log}_{10}\frac{T_1 - T_a}{T_x - T_a} = \frac{600\ DKX}{WQC}$$

where:

T_1 = Initial temperature of oil.

T_a = Atmospheric temperature. (For buried lines use mean daily temperature.)

T_x = Temperature at X miles from origin.

X = Length of lines in miles.

D = Outside diameter of line in inches.

Q = Flow in barrels per hour.

W = Weight of liquid in lb per barrel.

C = Specific heat of liquid.

K = Coefficient of heat loss. (Btu/hour/sq ft/°F)

For crude oil, assume

W = 330* and C = 0.5*

Formula then becomes:

$$\text{Log}_{10}\frac{T_1 - T_a}{T_x - T_a} = \frac{3.6\ DKX^*}{Q}$$

Above formula is for average conditions of lines buried about two feet deep. For California conditions, T_a = 70° for summer and 50° for winter.

K = 0.40 for summer.

K = 0.75 for winter.

DIRECTIONS

Given:

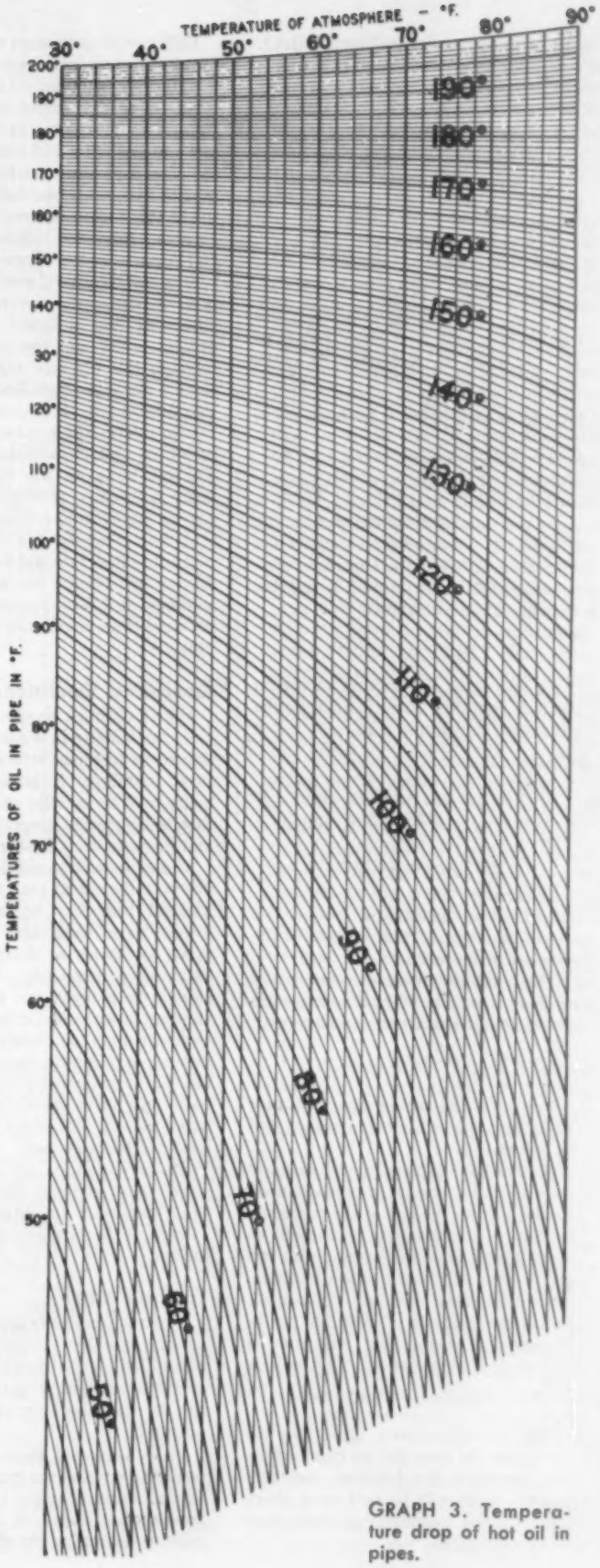
D = 8.625", Q = 400 bbl/hr., X = 2 miles, K = 0.75. For winter conditions, atmospheric temp. = 50°, initial oil temperature = 160°.

Compute $\frac{3.6\ DKX}{Q} = 0.1164$

From inside scale on left, set dividers to distance 0 — 0.1164. Beginning at intersection of 50° atmospheric temp. and 160° oil temp., step off temperature drop downwards on 50° line, getting temperatures of 134°, 114°, 98°, 87° etc. for two mile intervals.

*In formula a spec. gravity of .942 and a spec. heat of .50 was used. If other values fit better, multiply factor by ratio

$$\frac{.942 \times .5}{\text{spec. gr.} \times \text{spec. heat}}$$



GRAPH 3. Temperature drop of hot oil in pipes.

R at the upper critical limit is 1.13.

$$\frac{z}{s} \text{ must then be} = \frac{2000}{12 \times 1.13} =$$

148 centistokes

The temperature will be 160 F.

Likewise at the lower critical limit, R = 0.54.

$$\frac{z}{s} = \frac{2000}{12 \times 0.54} = 300 \text{ centistokes}$$

Temperature, 135 F.

Passing through this region then, the temperature will drop from 160 F to 135 F or 25 F. Referring to Gill's graph:

$\log_{10} t_m = \log_{10} \frac{160 - 50}{135 - 50} = \log_{10} 1.3 =$ 0.114. X then becomes:

$$\frac{0.114 \times 2000}{3.6 \times 12.75 \times 0.75} = 6.6 \text{ miles}$$

At the rate of 2000 bbl per hr, the oil will be in the unsteady region for a distance of 6.6 miles. The mean temperature will be about 147 F and the viscosity 220 centistokes.

$$R = \frac{2000}{12 \times 220} = 0.76$$

At this value the friction factor on the turbulent flow curve is 0.33, on the streamline flow curve 0.26.

$$P = \frac{0.33 \times 2000^2 \times 0.95}{12^5} =$$

5.00 psi per 1000 ft, also

$$P = \frac{0.26 \times 5}{0.33} =$$

3.95 psi per 1000 ft.

Difference:

1.05 psi per 1000 ft, or

$1.05 \times 6.6 \times 5.28 = 36$ psi for the distance of 6.6 miles.

The pumping pressure in such heavy oil lines is usually 800 psi or more, so that the calculated increase amounts to:

$\frac{36}{764} = 4.7$ per cent

For 1500 bbl per hr flow rate in a 12-in. line, the percentage increase will be less than 3.

Similar calculations can be made to show that the increase in pressure drop resulting from the use of the turbulent f factor in the unsteady region will be much higher than in the examples just given. That will be the case when relatively high flow rates are considered. For instance, a rate of 2000 bbl per hr through a 10-in. line will give a calculated pressure of 150 psi or $\frac{150}{650} = 23$ per cent.

The answer is that a 10-in. line will likely not be used for so high a flow rate, except in the definitely turbulent region. More will be said later about tapered lines, consisting of more than one size of pipe.

Different investigators show the "S" transition curve, previously mentioned, in different locations — Docksey and Beale near the upper critical limit, Prandtl about mid-way between the upper and lower critical limits. Bends in the line may cause turbulent flow to persist. All in all, the behavior of the oil in this region has not been sufficiently determined to follow the Docksey "S" curve near the upper critical limit.

It is recommended that an investigation, similar to the above, be made to determine the distance between the critical limits and the pressure drop through this distance for the friction factors along the turbulent and streamline flow curves. It is probably safe to use an intermediate value between the turbulent and streamline flow curves. The oil, however, will follow its own inner necessities as it flows along and pay no attention to calculations.

A line designed for the estimated maximum flow rate and for winter conditions will handle the oil during the summer at lower pressure and temperature if the maximum pumping rate prevails.

Operating Conditions

Heavy oil must be moved at a lively rate, particularly in winter, to keep the line from freezing. It is always necessary, therefore, if immediate movements will be smaller than the design rate, to determine temperature gradient and pressure drop for the smaller flow.

Under certain conditions, it might not be sufficient to keep the line open. The oil must then be pumped at the lowest "free" rate, and the line shut down for longer or shorter periods. If light oil is available, the heavy oil should be plugged out with it before shutting down, and the line warmed up with the light oil, heated, before beginning to pump the heavy oil.The line can be kept open by moving hot oil back and forth throughout the shutdown period. Hot water has also been used for this purpose.

These variations are mentioned to show that auxiliary calculations are often necessary to obtain a complete picture of the probable operating conditions.

Tapered Lines

Tapered lines have proved very satisfactory, in which a larger diameter pipe is installed for the unsteady and streamline flow sections. Lighter weight pipe can be used because of the reduced pressure.

If, as suggested above, the temperature gradient and the pressure drop for several sizes of pipe are plotted on cross-section paper, it is easy graphically to determine the effect on pumping pressure of a few miles of larger pipe in the colder sections of the line. A couple of triangles will enable the engineer to transfer the pressure drop curve for the larger line so that it will form the continuation of that of the smaller line. It is necessary to join the two curves at points of equal temperature in both lines.

Graph 4 shows such temperature and pressure gradients for 8-in., 10-in., and 12-in. pipe lines, each 16 miles long, for a flow of 1500 bbl of heavy Santa Maria crude oil per hour. An initial temperature of 190 F was chosen. Isotherms are drawn across the pressure gradients varying by 5 F. It is clear that an 8-in. line would require an impracticable pressure for the conditions cited above. How long a section of 10-in. or 12-in. pipe must be used at the colder end of the pipe line to move the oil at a pressure of say 800 psi?

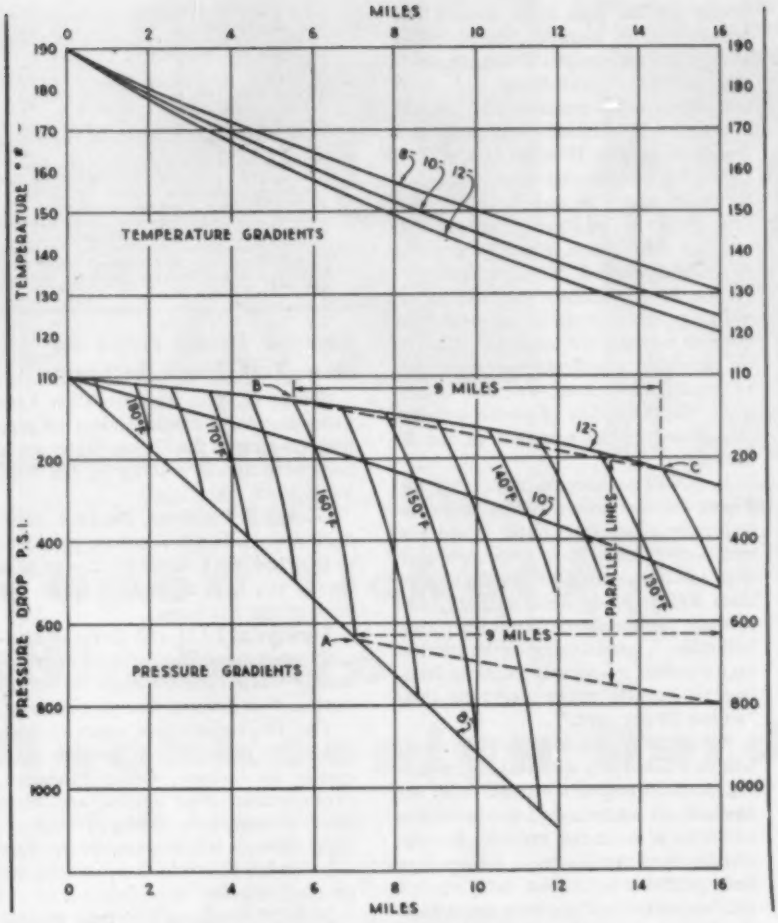
Directions to use the pressure curves for the solution of the problem will require more time than the manipulation of a couple of triangles for doing so. Let us consider 12-in. pipe. A cursory inspection will show that the 160 deg isotherm on the 8-in. pipe gradient might be the point at which the 12-in. pipe must begin. Now proceed:

This point, marked A, lies at mile 7, or 9 miles from the end of the line. The 12-in. pipe gradient is intersected by the 160 deg isotherm at mile 5.5, marked B. Adding 9 miles takes us to mile 14.5, marked C. Place a triangle on points B and C and transfer the direction between those points to point A. The line passes also through the 800 psi point on the 16 mile ordinate. Pipe of 12-in. diam would therefore be required for the lower 9 miles of the line. If the line through point A had intersected the 16-mile ordinate above the 800 psi point, less than 9 miles of 12-in. pipe would suffice; if below the 800 psi point, more would be needed. A second trial will usually hit the mark.

The problem can similarly be solved for 10-in. pipe. A greater length will be needed.

It takes little time to draw such a set of gradients. If the profile of a proposed line drops in the direction of the flow, work to a pressure point on the end ordinate equal to the proposed pumping pressure plus the favorable head. If the profile rises, substract the unfavorable head from the pumping pressure. Such gradients can be extended to longer distances and any other temperature point can be used for the start of the line. Lines of other sizes can be added.

This method was found very useful a few years ago when investigating the cost of increasing the capacity of an



GRAPH 4. Temperature-pressure gradients for 1500 bbl per hr of Santa Maria crude, 14 deg API, winter conditions, bare lines. K.7 Gr. T. 50 F.

8-in. pipe line with 12 pump stations, unequally spaced and along a rough profile. Having once decided upon a pumping pressure and temperature, largely based on existing facilities, the length of 10 or 12-in. pipe needed in each section was quickly determined. Only two sections required special consideration because the line passed through rather wide flooded areas. The graph also showed the pressure gradient for two 8-in. lines in parallel, and the distance for which the existing 8-in. line could be looped with a second line of that size was easily established.

All preceding remarks apply to a heavy oil line requiring only one pumping operation for a given maximum flow rate and pumping pressure. The pipe line size can now be selected, whether of one diameter or tapered, that will be lowest in cost of installations.

The next step consists of selecting heating and pumping equipment. Only a few remarks of a general nature will be made. A detail treatment of the problem is too voluminous for this article.

Heaters

Where steam is to be used, exhaust steam heaters are practicable, and add greatly to the overall efficiency of the steam cycle. It is not always possible to maintain a perfect heat balance, the heaters sometimes requiring more and at other times less steam than available from the pumps or pump drivers. The temperature of the oil cannot be raised higher than 160-165 F, except by providing an excessive amount of heating surface. If the oil must be pumped at a higher temperature, a live steam heater in series with exhaust steam heaters will prove an efficient addition.

In recent years, direct-fired heaters are being used with good results where steam is not available, or perhaps not economic because of the high cost of water. These heaters usually can burn natural gas or oil. To reduce the pressure drop through the heaters often only one-half the steam is taken through them, the temperature of the oil being raised high enough so that the mixture of the hot oil with the cold oil of the other one-half stream is at the proper pumping temperature.

Pumps

The cold oil from the tank may have to be boosted through the heaters and to the suction of the main pumps. In steam plants, low head reciprocating pumps are used. Rotary pumps driven by steam turbines or natural gas engines prove very satisfactory for this service. Centrifugal pumps have met with much favor where the viscosity at the pumping temperature is not more than, say, 250 SSU. Whether they will be best for the purpose also at higher viscosities is a matter of economics. Steam turbines are excellent drivers for such pumps. Natural gas engines and diesel engines are also entirely satisfactory and economic in operation. Electric motors are simple, cheap at first, but usually higher in operating cost. Reciprocating pumps are more expensive than centrifugal pumps, particularly large compound flywheel pumps with Corliss valve engines. This type of pump, however, operates with high efficiency. Reciprocating power pumps can be driven by means of any of the prime movers previously mentioned.

Yearly Cost

As discovered for light oil lines, a detailed analysis of the yearly overall cost of line and pumping equipment is necessary to make the proper choice.

It is important to investigate performance requirements for the pumping equipment not only for maximum flow conditions, but also for reduced rates and to provide for such reduced rates.

The balanced design of a heavy oil line requiring a number of pumping plants is merely an extension of this discussion.

Special Problems

The flow formulas discussed in this article do not apply to oil in liquid-vapor composition. This flow condition is discussed by F. W. Dittus and A. Hildebrand, in the April, 1942, ASME Transactions.

It often happens that an oil field proves extensive beyond first estimates. The pipe line serving the field might then become too small. It is a question of economics whether to replace it with a larger line or whether to parallel it, entirely or partially, with a line of equal or different size. Such multiple lines are referred to as loops. If the same size pipe is used in a loop, the stream will split equally, and the design calcula-

tions are simple. They are less so if different size pipes are considered, particularly when the flow is not isothermal.

A detailed discussion of calculation procedure is not within the intended scope of this article. Through acquaintance with the effect of factor changes in the flow formulas upon the result, however, will enable the designer to solve such problems without difficulty. Tables giving the flow capacity of different size pipes for the same length, pressure drop and viscosity are helpful. In the paper by Hollander, referred to, the use of diagrams is shown for an ingenious solution of such problems. The paragraph on tapered lines also suggests a solution.

Oil expands as it is heated, but its volume shrinks again slightly when under pressure. The specific gravity decreases with expansion. A few values are given here to illustrate these relationships. They are taken from Bureau of Standards Journal of Research, Vol. 5, November, 1930.

Oil: API 17.5 deg; specific gravity at 60 F. 0.95; kinematic viscosity at 210 F 44 centistokes.

Temperature, °F	Volume 0 psi	Volume 700 psi
60	1.00	0.998
120	1.022	1.019
200	1.052	1.049
300	1.093	1.088
400	1.137	1.30
500	1.186	1.176
600	1.24	1.23

In refineries oil is sometimes pumped at a high temperature. At 600 F, even when under high pressure, its volume is increased by more than 20 per cent. In long pipe lines the oil is seldom pumped at a temperature above 200 F. The volume increase will be about 5 per cent, the oil shrinking as it cools in the line. The average increase in a line might be 3 per cent.

The Reynolds number is not affected by the volume increase:

$$R = \frac{Q}{d \times \frac{z}{s}}$$

The increase in Q is cancelled by the corresponding decrease in s.

The pressure drop increases proportionately to the volume increase:

$$P = \frac{f\,s\,Q\,Q}{d^5}$$

The increase in one Q is also cancelled by corresponding decrease in s.

The increase in the other Q increases P. Such hot oils will be in turbulent flow. The effect on streamline flow P is the same as on turbulent flow P.

Conclusion

It is hoped that this simple review of the factors entering friction loss calculations for oil pipe lines and of the possibilities for manipulating formulas and for plotting graphs to suit the reader's individual preference and need will stimulate his curiosity and interest to actual manipulation of formulas and design of graphs. It is the best way to shape the information into a tool that he can handle with understanding and skill. Field tests on flowing lines are also of great importance. The engineer will be gratified to find that pipe lines perform to his predictions. He must not be too surprised now and then to experience an unexpected behavior in a hot oil pipe line. It will very likely be due to extended unusual weather conditions, the possibility of which was not considered in the selection of the K factor.

It is well to keep in mind that the Pigott friction factor curves and consequently those on Graph 2 are not necessarily final. It is quite probable that additional tests on operating pipe lines will be made while carefully observing conditions of flow, tests that will make it possible to give the friction factor curves shapes and locations leading to results more accurate than "within 10 per cent."

To assemble and interpret such tests will be a laborious undertaking requiring much correspondence and time. An obstacle to accuracy of performance will always lie in the inability to control the flow conditions in a long pipe line, particularly in one carrying hot oil. No matter how accurate the curves, the degree of compliance of such a pipe line with its design depends largely upon the excellence with which temperature, soil, and moisture conditions along its route were prognosticated.

It is further not beyond imagination that the manufacturer of steel pipe will develop processes for pipe rolling that will leave the interior surface at a smoothness approaching that of brass tubing. As a matter of fact, pipes with very smooth interior surfaces have been available for several years. They were largely used for the conveyance of water.

Lastly, careful study of the voluminous literature on the flow of viscous liquids and observations of his own might lead the reader to conclusions varying more or less from those stated.

Bibliography of Related Articles

1. *Friction Factors for Pipe Flow*, Lewis F. Moody, Professor, Hydraulic Engineering, Princeton University. *ASME Transaction* 1944. Also published as *Tentative Standards of Hydraulic Institute* 1948. Secretary: C. C. Rohrbach, 90 West St., New York 6, N. Y.
2. *Crude Oil Flow Characteristics Experienced In Large Diameter Pipe Lines*, Lowell E. Anderson, Service Pipe Line Company, Tulsa, Oklahoma. *The Petroleum Engineer*, Reference Annual, 1950.
3. *Pressure Loss in Oil Pipe Lines*, W. L. Kennedy, Jr., Service Pipe Line, Tulsa, Oklahoma, *The Petroleum Engineer*, November, 1954.
4. *The Pumpability of Fuel Oils*, F. Gill and R. J. Russell, Anglo Iranian Oil Company, Ltd., Sunbury-on-Thames, Middlesex, England. Paper read on May 11, 1953, before Division of Refining, American Petroleum Institute. Ind. Eng. Chem. 46 (1264 to 78) 1954.
5. *Pipe Lines for Viscous Fuels* P. E. Ford, Anglo-Iranian Oil Company, Ltd., Beaufort House, Gravel Lane, London E 1. Paper presented at 4th World Petroleum Congress, Rome, June 1955. Published in Proceedings of Congress.
6. *Selecting Pipe Line Diameter*, George F. Downs, Jr., and George R. Tait of Phillips Petroleum Company. Paper presented at November, 1953, meeting of American Petroleum Institute. Published *The Petroleum Engineer*, Reference Annual, 1954.
7. *Oil Pipe Line Operating Pressure Practices*, F. C. Whiteside, Continental Pipe Line Company. *The Petroleum Engineer*, November, 1951.

Buckeye Shares Listed on New York Stock Exchange

Shares of The Buckeye Pipe Line Company, largest independent oil pipe line company in the United States, have been admitted to trading on the New York Stock Exchange.

George S. Patterson, Buckeye president, and G. Keith Funston, president of the New York Stock Exchange, witnessed the first transaction from the floor of the Exchange.

Buckeye as 1,121,483 shares of capital stock outstanding, held by approximately 6000 shareholders in every state and in several foreign countries.

The 70-year-old firm operates both crude and product lines, located principally in Indiana, Ohio, Michigan, Pennsylvania, New Jersey, and New York. Its customers consist of major oil companies in those areas. More than 625,000 bbl of crude and products are handled daily by the company.

In 1955, Buckeye had total income of $19,055,452 with net income after taxes of $2,242,027, equal to $2.05 per common share. For 1954, total income was $17,129,961 with net income after taxes of $1,972,431, equal to $1.80 per common share.

For the first quarter of 1956, total income was $5,569,046 with net income after taxes of $788,646, equal to 72 cents per common share. For the corresponding period in 1955, total income was $4,666,757 with net income after taxes of $542,580, equal to 50 cents per common share. Shares of The Buckeye Pipe Line Company were formerly traded on the American Stock Exchange.

Mid-Continent Pipe Line Moves to New Quarters

The Mid-Continent Pipe Line Company has moved its Tulsa, Oklahoma, general offices from the Mid-Continent Building at 4th and Boston to the Sunray Building at Ninth and Detroit, it was announced here recently by J. M. Linehan, president. Mid-Continent Pipe Line is a subsidiary of D-X Sunray Oil Company, which in turn is a subsidiary of Sunray Mid-Continent Oil Company.

P 605.

Oil gager stamps vital information on a run ticket in the presence of pumper.

With help of tank tables, trained clerks in division office calculate and verify barrels-of-oil-run from run ticket figures.

Automation in Action

Taped Tickets Eliminate Bookkeeping Burdens

YESTERYEAR'S oil gager, of necessity, was a sturdy breed. He walked or rode a horse or mule hundreds of miles during his seven-day week and did it in spite of all hazards. Like the mailman, he had to get through, and if that meant swimming a swollen stream or gaging and testing oil far into the night, that's exactly what he did. That packsack of equipment could get plenty heavy — especially the centrifuge machine that was powered by the muscle in his arm.

The life of a gager for Humble Pipe Line Company today is, physically, an easier one. With the advent of the automobile and the centrifuge operated off the car battery, he is able to trigger the transport of more oil in less time — and do it more comfortably.

But strangely enough, one of the gager's activities — bookkeeping — has grown increasingly cumbersome in recent years. Originally after filling out run tickets, the gager merely sent them in to the Houston office, where the gross volumes were calculated and verified manually.

About four years ago, this method was changed, so that the gager did all run ticket calculations in the field, and sent his reports to Houston to be verified by IBM equipment. The method was accurate, because machine verification detected any errors by the gager, but the correction then was a time-consuming procedure.

The Humble Pipe Line gager was spending more and more of his time — perhaps a fourth of his workday — slaving over an adding machine. But now, thanks to still another new run ticket process in use by Humble Pipe Line, the gager will be relieved of most of his clerical chores. And because the average gager is not a trained accountant and would rather move oil than keep books, he's naturally pretty happy with the plan.

In July, 1955, the methods and procedures staff in the internal audit division of the accounting department (Humble Oil and Refining Company) along with Humble Pipe Line personnel started a study with four chief aims:

(1) To cut down on run ticket field clerical errors.

(2) To relieve gagers of their increasing clerical duties.

(3) To speed the information from run tickets to all departments concerned, and

(4) To speed the processing of oil payment checks.

The elimination of clerical miscues certainly was no new problem. An 1887 gager's manual issued in Harmony, Pennsylvania, quotes an 1882 rule: "If the number of your errors in one month does not exceed four (4) per cent of the number of runs in that month, your wages for that month will be ninety ($90) dollars; if the number exceeds four (4) per cent, your wages for that month will be seventy-five ($75) dollars; if it exceeds ten (10) per cent, you will be liable to dismissal."

Errors were never this serious a problem with 37-year-old Humble Pipe Line. Such errors as did creep in were readily detected and corrected after the run tickets reached the Houston office. They were of enough consequence, however, that the methods and procedures staff put the old system of run ticket recording and accounting under close scrutiny. Here, basically, is how they found the five divisions of Humble Pipe Line to be operating:

The gager, after returning from his leases where he had gaged, tested, and run oil would fill out his run tickets (small multi-copy forms containing basic information from which payment for oil is made). From these he would calculate the gross barrels run from tank tables supplied by the Houston office, and post this information in proration records. He then entered on a seal record the numbers of seals he had placed on tank valves and finally mailed his run tickets to Houston.

Under the new system, the proration records, the tank tables, and the seal records have been moved to the division office. The only clerical work the gager does is to fill out his run ticket and mail it to the division office, where trained personnel do the rest with a

Manually-operated "Add-Punch" machine transfers to perforated tape all data on run ticket pertinent to oil payments.

Now on punched tape, run ticket batches are threaded through teletype unit, which transmits them to Houston mail office. Sending time of one run ticket: 11 seconds.

high degree of speed and accuracy.

Here, then, the study accomplished Aim No. 1 (reduce field clerical errors) and No. 2 (lighten gager's bookkeeping load). Aims No. 3 (speedier transmission of information) and No. 4 (faster oil payment check processing) were handled with similar dispatch.

The information on the run tickets, when received at the division office, is processed on an "Add-Punch" machine with a tape-cutting attachment. After various checkouts to verify accuracy of the run ticket, the tape is fed into a teletype sender and transmitted to Houston.

Another teletype machine duplicates the tape in Houston, where it is fed into a tape to card-punch machine to process the cards for further use. These cards are then placed in business machines, which verify all the calculations and post the information to the various accounts. Finally, checks are written for oil payment — all without further calculations by clerical personnel.

This plan was set up on an experimental basis on the Refugio district of the Southwest Texas division (Corpus Christi) in September after the methods and procedures study in July. West Texas division began on the same trial basis October 1; East Texas, February 1, 1956; North Texas, March 1; and the Southern division followed April 1.

Headaches have been many, of course, but what of the results? Among the 40 oil gagers in the Southwest Texas division (where the system is in full operation), complaints about heavy bookkeeping duties have been reduced to zero. When maximum efficicency is reached, it is estimated the time to process oil payment checks will be cut a full two days. And as for accuracy, here's a convincing "before" and "after" story: In January, 1955, a total of 160 calculation errors were corrected in the Houston office for the Southwest Texas division. In March, 1956, with the new system operating full steam, **there were no errors!**

The success of the new run ticket process has been such that it has attracted widespread interest outside Humble Pipe Line Company. Several other oil and pipe line companies are studying the procedure for their own use.

Where now? The process, now functioning throughout the Southwest Texas, West Texas, East Texas, and Southern divisions and partially in the North Texas division, presently is operating at about 90 per cent capacity. It is estimated that during June, for instance, about 38,700 of the 43,000 run tickets were processed by the new method. By July 1, the system was scheduled for complete operation in all five divisions.

With this happening, all 269 gagers for Humble Pipe Line will have abandoned their adding machines with the knowing satisfaction that newly-developed business machines and trained personnel have lifted a bookkeeping burden from their shoulders.

Acknowledgment

Reprinted from the May-June, 1956, issue of THE HUMBLE WAY, by permission, Humble Oil and Refining Company, Houston, Texas. ★ ★ ★

Run tickets on tape are punched out in Houston on teletype receiving apparatus.

Automatic tape-to-card converter takes information from tape, transfers it to IBM cards. Chance for human error is remote.

Finally, IBM cards are fed into machine, which prints oil payment checks. System should cut payment time by two days.

PIPE LINE COMMUNICATION & CONTROL

Here's the "inside" story on . . .

Time Code Control and Data Handling Systems

Paul K. Eckhardt
Project Engineer
Union Switch and Signal
Division of Westinghouse Air
Brake Company
Swissvale, Pennsylvania

THE DESIRE FOR MORE EFFICIENT operation in those industries where the equipment is spaced far apart and over hundreds of miles of territory, such as a pipe line system, places special requisites on the technical aids needed to gain this efficiency.

One of these technical aids is centralized control and data handling with which the dispatcher or operator at one point can control equipment at the remote points and determine the status of the equipment and operations at these points.

The distances and the number of functions to be controlled make the cost of direct wire connections for centralized control and data handling prohibitive. The end result therefore must be obtained over a simplex leg, over one pair of line wires, a microwave system, a radio link or combinations of these transmission facilities.

In effect, centralized control must meet high-grade communication circuit requisites where a human being on one end of the circuit sends instructions directly to equipment at the other points in the circuit and receives direct answers therefrom. The lack of ability on the part of the operating equipment to compensate for message error or noises in transmission places added responsibility on this communication system.

One type of centralized control and data handling system that has found widespread use in service is known as the time code system, which derives its name from the nature of the code step characterization.

The broad principles employed in the time code system and the information it handles will be given in this paper, which has been limited to the general characteristics of time code.

The Time Code

The first point is the time code itself. Consider the code from the stand-

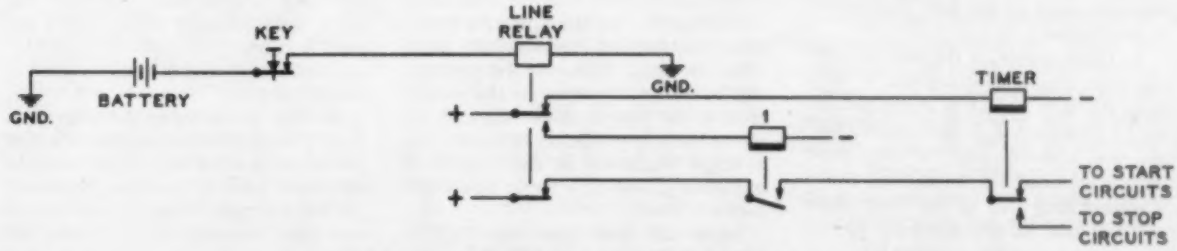


FIG. 1. Simplified time code control circuit.

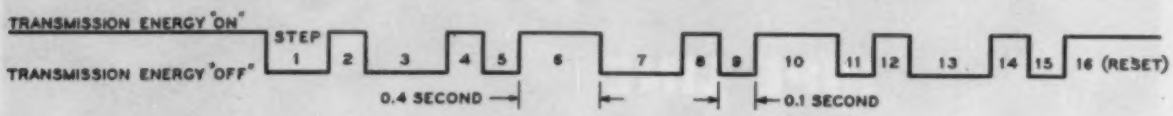


FIG. 2. Typical time code pattern.

point of its appearance on the transmission circuits.

Let us think about a transmitted time code pattern and the simplest form of time code control—one without checks or balances and which transmits to one point only. Fig. 1 illustrates a simplified form of circuitry using a single wire with ground return, a battery, a line relay, a slow releasing relay energized over the line relay, an auxiliary relay, and a control key.

This simple circuit is shown wired for the remote control of "start-stop" functions. When the key is depressed the line relay is de-energized and releases immediately, following the key closely. When the line relay releases it de-energizes the slow acting timer relay, which may or may not drop depending on the length of time the key is depressed.

Relay 1 is energized when the line relay drops to prepare for the desired circuit action when the control key is released and the line relay is re-energized. If the key is depressed for a short time, the timer relay will not have released, relay 1 will be energized, and when the key is returned to its normal position the line relay will be re-energized. The start circuit is now energized.

If the key had been held down for a longer period the timer relay would have released and at the end of the period when the line relay picked up, the slow acting timer relay pick-up would have been delayed and the stop circuit would have been energized. The 1 relay releases and the timer relay picks up in that sequence to restore the circuit to normal. Thus, by manipulating the key for long or short periods of time the selection of a stop or a start function was made remotely. With a single step operation of the key, the control is established.

In this example, if the step is short the start circuit is energized, if it is long the stop circuit is energized. In actual practice, with checks added and two-way transmission, the long steps usually are used for starting and either a second long step or the short steps are assigned to the stopping operation. In any case this presents a simple picture of the line circuit action in time code.

This example, in effect, is a single step time code. The step is initiated by removal of energy from the line and terminated when energy is placed back onto the line at which time the character of the step is delivered to the function under control. The information during the steps is established by its time length. The line circuit energy plot for this single step code would simply be a single energy interruption of long or short duration.

The addition of functions to be controlled at one location and an increase in the number of locations to be controlled demand that the code carry the number of steps necessary to accomplish all functions assigned to it. One method of handling a number of different locations is to use the first portion of the code to establish selection circuits. Each location then will have a different selection through which the actual function control steps are channeled. The latter part of the code is used to control the functions. A typical code pattern is shown in Fig. 2.

The first step in this case is used for transmission circuit checks and control code preferencing to insure that the transmitting and receiving locations are set up to transmit in their turn and are synchronized. The second through eighth steps are used in combinations of three long and four short to establish the group selection and the ninth through fifteenth steps are used for the actual control of functions for the location selected; the 16th step being used for resetting and synchronizing of the code equipment.

In the example shown, the station or group being handled by that code is 367 and at station 367 the 10th and 13th functions are, for example, being turned on; the other functions are being turned off.

The description thus far has dealt with controls. The same patterns apply when information is transmitted back from the field. These return patterns can be formed by changing the energy level in the line circuit in the case of direct current operation or by keying a single frequency in the case of a modulating tone or a single frequency carrier circuit.

Note also that after the code is started the "transmission circuit energy on" steps carry information as well as the "transmission circuit energy off".

Time Code System Requisites

The pattern described is a progressive type of information transfer being transmitted in sequential steps. This presents the requisite of step identification at the transmitting station so that the information to be transmitted on that step is inserted only during that step. Likewise, each step must be identified at the receiving station so that the information contained in the step is fed to the proper function; the station selection, function, and step relationships being predetermined as indicated by the previous discussion.

The foregoing requisite is met by counting the steps with a chain of relays; a relay being operated in the chain for each count. The keying relay at the transmitting location that is used to form the pattern on the transmission circuit, indirectly advances the relay chain each time it changes armature position. The receiving relay at the receiver following the code pattern advances the relay chain each time it changes position. The relay chains are then advancing and counting in synchronism, the No. 1 relays being energized on the first step, No. 2 relays on the second (when No. 1 is released) etc.

Another requisite is to insert and identify the long or short time information on the individual counts. That is, to establish whether the count is intended to be long or short at the transmitting end and to sense whether it is long or short at the receiving point or points.

This is accomplished by using accurately timed slow releasing relays in conjunction with the lever contacts at the control point or the function contacts at the slave station during transmission. The count relay and the keying relay at the transmitting location are also incorporated. Likewise the same corresponding timing relays are used in conjunction with the count relay and the receiving relay at the receiving point.

At the transmitting location, the keying relay takes its step position and the corresponding step count relay in the chain takes its position. Indirectly the keying relay de-energizes one of two slow releasing relays, a slow release being assigned to each of the two keying relay positions. A circuit is established from an external terminal

on the code unit corresponding to the count over the count relay and the slow releasing relay to the keying relay. If manipulation of a lever on the control panel places battery on the count terminal at the unit then the keying relay is held in its existing count position until the hold circuit is broken up by the dropping of the slow release relay and a repeater of it. The step has then been in existence for the drop out time of the slow release relay to form the longer time interval. If battery is not placed on the external terminal the holding circuit will not be in force and the keying relay will move to the next step position shortly after its count relay becomes energized. In this case, the step will be of short duration.

At the receiving location a circuit is established over the receiving relay contact, over the slow releasing relay, which is de-energized when the receiving relay takes the existing count position, over the count relay in the chain to an external terminal on the unit wired to an interposing relay corresponding to the count.

Should the step length be long, the slow releasing relay when released establishes a circuit over the count relay to the terminal. At the end of the step, battery from the receiving relay over the released timing relay, over the count relay to the terminal to the interposing relay, will energize the interposing relay. If the step had been short, the slow releasing relay would not have released during the count and the interposing relay would not have been energized.

Let us review the foregoing. The requisite of counting is met with a progressive relay chain; each relay being energized one at a time from the first through the last count as the keying and the receiving relays take their alternate positions.

The time character is established by presence or absence of battery assigned to a terminal post, one post for each count. When battery is present on a given count a hold circuit (hold up or hold down) on the keying relay is established until a slow releasing relay and its repeater releases. When battery is not present the holding circuit is not in force and the count is advanced immediately over the count relay.

The time is sensed at the receivers by the presence or absence of battery ove r the count relay to an external post of the unit connected to an interposing relay. The presence or absence of battery is governed by slow releasing relays attempting to follow the operations of the received relay. When the steps received are long enough for the relays to release, battery appears on the terminals. When the steps are too short for the slow releasing relays to drop, battery does not appear at the terminals.

The foregoing stated the basic count and step forming requisites for time code systems and described briefly how these requisites are being met. There are other requisites common to all systems of centralized control. These are mentioned below in recognition of the fact that they are met in the detail design of time code systems.

Where party line operation exists, automatic preferencing must be established to insure that only one location will continue to transmit should several locations start to send messages simultaneously. Likewise, when one location is transmitting, another location cannot possibly be allowed to interfere by starting to transmit. A third requisite is that information from a station held off the circuit while another is transmitting will be stored and transmitted as soon as the transmission medium is free to handle it.

The system should be free from registry of false control information injected by disturbances in the transmission circuitry. A corollary of this is that the transmission circuit should be as free of disturbances as it is possible and practical to make it.

Information Handling

Having indicated the broad basic, principles and briefly describing the requisites for time code systems, let us consider the methods of handling the information.

First, the injection of information into the system. As mentioned previously, the presence or absence of battery on the code unit terminal corresponding to the transmitted step will cause that step to be transmitted either long or short. Therefore, in effect, contact position information is injected into the unit. This information for one step can come from a two-position control lever, battery being fed to the terminal over one position of the lever and removed from the terminal over the other position of the lever.

Each step, therefore, can be made available for the control of a two-position function. In similar manner, two steps will handle a three-position lever, one extreme position applying battery to one terminal, but not the other, the opposite extreme position applying battery to the second terminal, but not the first, and the center position removing battery from both terminals.

In a similar manner, function positions can be represented by contacts actuated by the field equipment. These contacts apply or remove battery from the unit step terminals.

A two-position function such as "on-off" has the "on" position contact feed battery to a step terminal on the unit; the "off" position being represented by absence of battery from the same terminal or vice versa.

Three-position functions such as "open-in-transit-closed" require two steps, the contact information being fed to the unit as mentioned previously for control lever contacts. That is, each extreme position places battery on one or the other of the terminals and the intransit condition places battery on both posts.

The foregoing describes the insertion of control and function information in a straightforward manner — battery is simply applied to or removed from the step post on the unit. Combinations are available that require some special circuiting at both ends of the system. For example, two steps represent four possible conditions:

(1) One step long the other short;

(2) The first step short, the other long;

(3) Both steps long;

(4) Both steps short. This application is special and in the interest of simple end circuitry, external to the unit, is held to a minimum.

Thus far, the inference has been that only control and functional position information can be fed into the system. Consider next the matter of digital data that it may be desired to insert. Very low order digital data can be inserted using one step per digit. It becomes obvious that step requisites for straight digital handling build up rapidly unless auxiliary circuits are adopted to sort out units, tens, hundreds, etc.

A more economical approach is to convert digital to binary form or to read out binary directly from the metering unit, inserting it directly on the step terminals. The system will transmit this information when demanded, either by programming or by over-ride dispatcher demand. The information will appear as long and short combinations corresponding to the reading inserted.

Let us now consider the interpretation and registry of the information. It was pointed out previously that the information received is interpreted step by step. If the step length is long, battery appears on a terminal post corresponding to that step and if short battery does not appear on the post. The interpretation then appears in the form of energized interposing relays or a de-energized interposing relay for each step used.

In the case where controls are issued to a multiple station system, all

receivers follow, but only one station will find that it has three of its group selection relays chosen. This is according to previous discussions of grouping control functions. Only this station will follow and interpret the remainder of the control code. Likewise, indications will channel through station selection interposing relays to select the correct group of indication circuits being served at the control point.

The "read-out" into interposing relays is progressive with the reception of the code. The action desired from the interposing relays can be initiated immediately upon their change in position or the action can be delayed until the code has been completed. The first action is known as progressive delivery, the latter is the one that is often employed to check out interlocking circuitry before delivery. If the check-out is not satisfactory, delivery is cancelled and the system answers back accordingly.

The interposing relays when energized can be sealed to give an established record until a change takes place to revise the record, or they can be operated temporarily until the desired end function has been started and then released.

The functional controls and indications, when read out, result in the functioning of the operational equipment or a lamp display. The data handling information when read-out in the form of combinations of energized and de-energized relays can be circuited into a numerical lamp display, into a printer, into a translator and chart recorder, or into tape punch where the tape is used for retransmission by teletype.

Components

The main components, aside from the control console in the system, are the code unit and the storage unit that houses the interposing relays. Fig. 3 shows a rear view of a typical code console with cover removed. Note that this is an all-relay system, employing relays that have been designed to meet the requirements for such a system. The unit is plug-connected for ease in removal for inspection and overhaul. A glass front cover allows periodic visual inspection to be made with the unit in place. Note the numbered counting chain relays and two timing relays (1L and 2L) are used to determine and interpret step lengths. The same relays, including the count relays, are used when the unit transmits and receives. A plug-in terminal board to which the count step wiring is attached is used both for forming steps during transmission an dfor energizing interposing relays when receiving. The transmission circuitry and the battery supply also feed the unit through this board.

There is no need to change unit wiring at any time, all revisions such as additions in circuitry are made external to the unit. ★ ★ ★

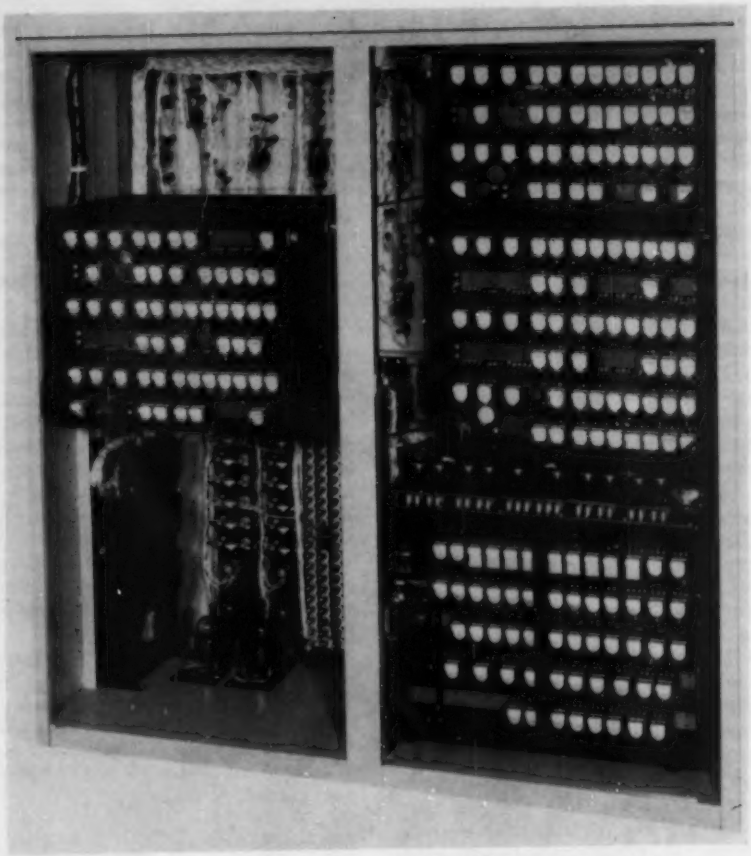
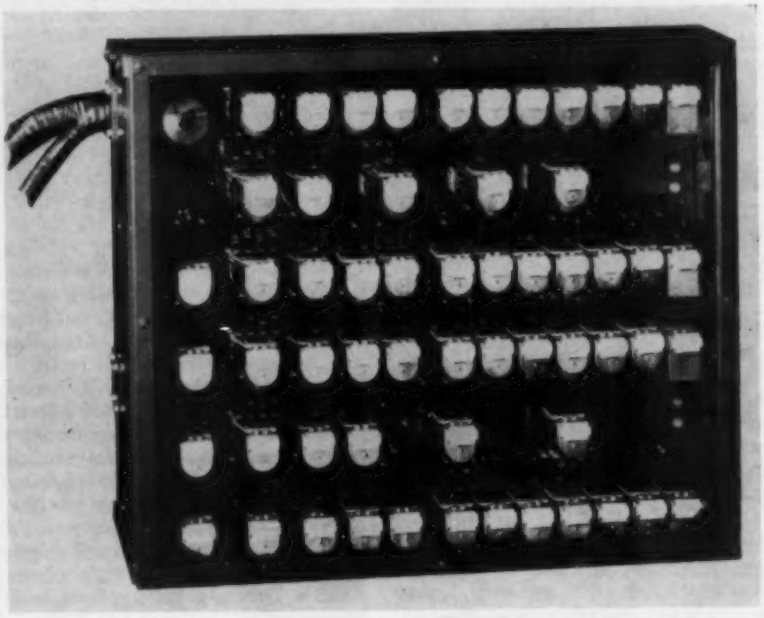
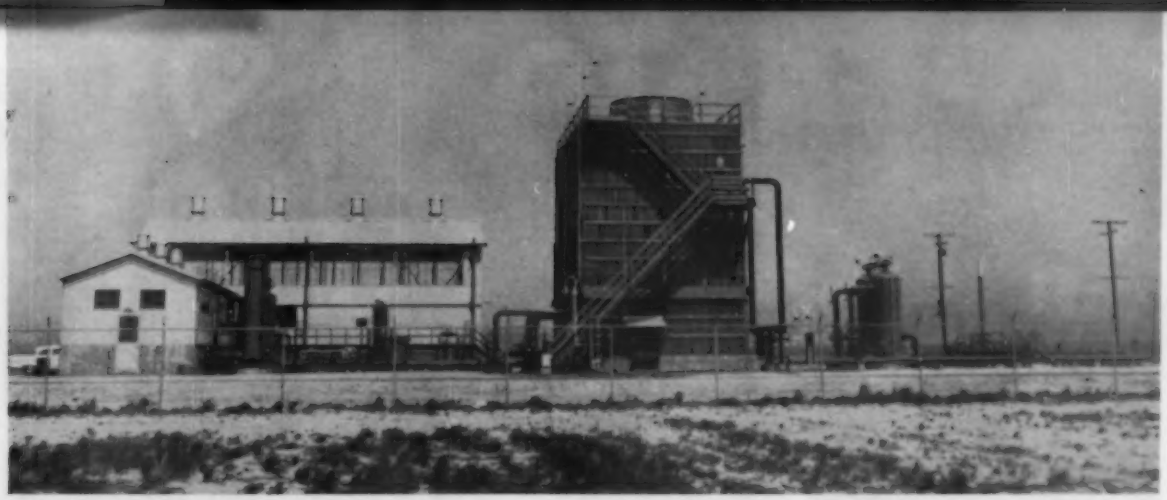


FIG. 3. Rear view of a typical code console with cover removed.

FIG. 4. Typical code control unit.



Paper originally presented before the AIEE Petroleum Technical Conference, Houston, Texas.



EXCLUSIVE

General view of south elevation of San Diego Gas & Electric Company's new compressor station.

P 624.

Compressor Station Incorporates New Design Features

Stress laid on: (1) General plant arrangement; (2) piping layout; (3) instrumentation and control; (4) water treating; (5) preparation of station site; (6) cooling system; (7) metering.

Henry Farnsworth and Jerry Stumm

Project Engineer, The Fluor Corporation — *Pacific Coast Editor*

DUE to the rapidly growing population in the extreme southwestern area of California, served by the San Diego Gas & Electric Company, it became necessary for the company to construct a new compressor station, to supplement an existing one, on the 16-in. main line serving San Diego County.

The new station is situated near the "head end" of the line at a point approximately one-half mile from where the 16-in. line takes suction from the two 30-in. parallel lines of the Southern Counties Gas Company, near Moreno, in Riverside County.

The new station consists primarily of two 1100-bhp supercharged gas-engine-driven compressors, together with necessary equipment, which provides an increase in gas flow from a nominal volume of 83,000,000 std cu ft per day before the plant was put on stream, to a new nominal volume of 112,000,000 std cu ft per day. Space has also been provided for the addition of two similar compressor units and their facilities.

Main compressors consist of two 1100-hp gas-engine-driven units. Gas volume intake bottles can be seen at right directly above air-cooled compressor cylinders.

General Specifications

The process piping system and equipment within the station is designed for a maximum safe working pressure of 850 psig. The transmission gas received at the plot limit is metered in two parallel meter runs, one 12 in. and one 16 in. diam. It then passes through two gas cleaners to the compressors where it is discharged through two parallel banks of atmospheric cooler sections and returned to the transmission line at the plot limit.

The building arrangement consists of a 28-ft wide by 64-ft long main compressor building and a separate smaller auxiliary building that houses the major portion of the auxiliary machinery and the warehouse, together with a

Looking along the main operating platform toward office and control room. Gas intake header at right and discharge header at left.

Control board in office showing flow meters, indicators, emergency shutdown controls and alarms.

combination office and control room.

The plant facilities were designed and constructed by the Fluor Corporation, Ltd., of Los Angeles.

Preparation of Site

A soil analysis of the plant site indicated the necessity of extensive compaction. All main excavations were dug 4 ft below the proposed concrete level and the earth replaced and compacted in 6-in. thick lifts. Subsequent tests showed the soil preparation under the main foundations to be in excess of 90 per cent compaction.

Although every precaution was taken to improve the soil bearing, a continuous concrete mat was poured as a spread footing under the compressor blocks. This mat extends the entire length of the compressor building and is approximately 5 ft wider than the building. The precautions taken in preparing the soil, and the extra considerations taken in the foundation design, have since proved that added cost was warranted.

Plant Arrangement

San Diego Gas and Electric Company engineers developed the general arrangement of the plant and buildings. Before finalizing the design of the building arrangement, an economic study was made to determine the merits of two separate buildings to house the main compressor units and the auxiliary equipment as compared with one large building. It was concluded, after considering all the ramifications, that the two-building arrangement would be more economical.

An auxiliary building, separate from the main compressor building therefore was provided, containing a combination office and control room. The control room is close enough to the main compressor house to provide the operator with a view of both compressors through specially placed windows. Acoustic insulation has been used quite effectively to keep out engine noise, and separate building footings eliminate the transference of any mechanical vibration that might upset the adjustment of the delicate instruments on the panel in the control room.

A clean building line is provided on the side of the plant facing the main highway. The only equipment in view on this side are the engine exhaust mufflers, which are an especially quiet type that reduce the exhaust pulses to a minimum noise level.

Piping Layout

The piping layout is compact and simple with most of the pipe runs being short and straight. The utility lines, which are held to a minimum, have all been grouped on the south side of the plant along with the transmission gas piping. This arrangement provides ease of operation, low maintenance, and minimum initial cost. The grouping of these lines was greatly facilitated because of the fact that gas compression is single stage.

All piping is carried on concrete supports at grade elevation with a complete absence of any overhead piping. The piping is tied to the supports with specially designed hold-down supports, which feature, together with the installation of pulsation dampeners at the compressor cylinders, has reduced to a minimum the presence of either pulses in the gas flow or excited mechanical vibrations in the piping.

Cooling System

As stated earlier, the number of utility lines was held to a minimum. This was mainly possible by the use of a single circuit jacket water system as compared with separate circuits for the engine power jackets and the lubricating oil coolers. In this single circuit the jacket water is pumped through the water coolers, the lubricating oil coolers and engine power jackets, all in series and in the order named.

Large lube oil coolers were used for the full flow of cooling water and are

situated outside the building for ease of maintenance and to reduce congestion.

A constant water temperature is automatically controlled through the use of special temperature and pressure controllers and butterfly valves in both the discharge lines from the jacket water coolers, situated in the cooling tower, and a by-pass around these coolers. This arrangement has proved quite satisfactory over a wide range of heat loads.

The gas and water streams are cooled by atmospheric, or open-tube type, coolers in a mechanical draft water cooling tower where water is sprayed over the tubes. A water cooling tower was used in preference to air or dry type cooling due to the reduced temperature to which the discharge gas is cooled.

Water Treating

All cooling water in the plant is treated. The closed jacket water stream is treated for hardness and with an inhibitor against corrosion. The cooling tower spray water is treated to reduce the formation of scale, algae, and for corrosion.

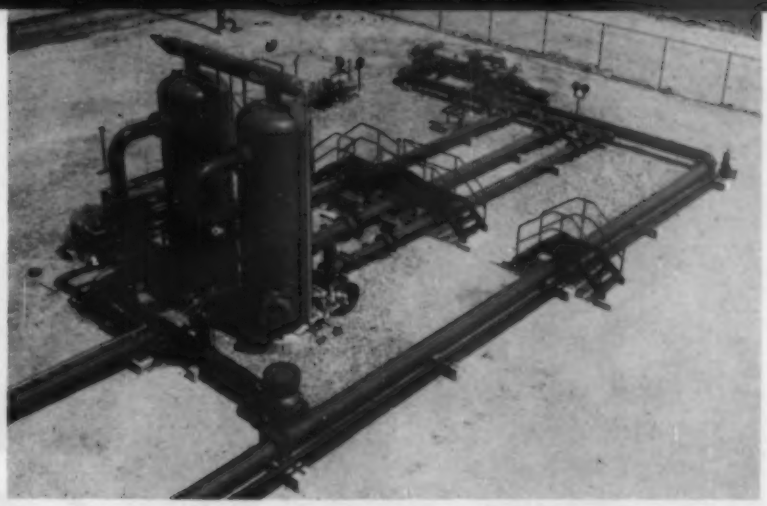
A simple, effective means of introducing the acid used for scale control in the spray water is accomplished by the use of a small glass suction pump that employs a slip stream from the water blow-down circuit. A pH indicator is installed adjacent to this acid injection system, providing the operators with control of the acid content in the water system at all times.

Instrumentation and Control

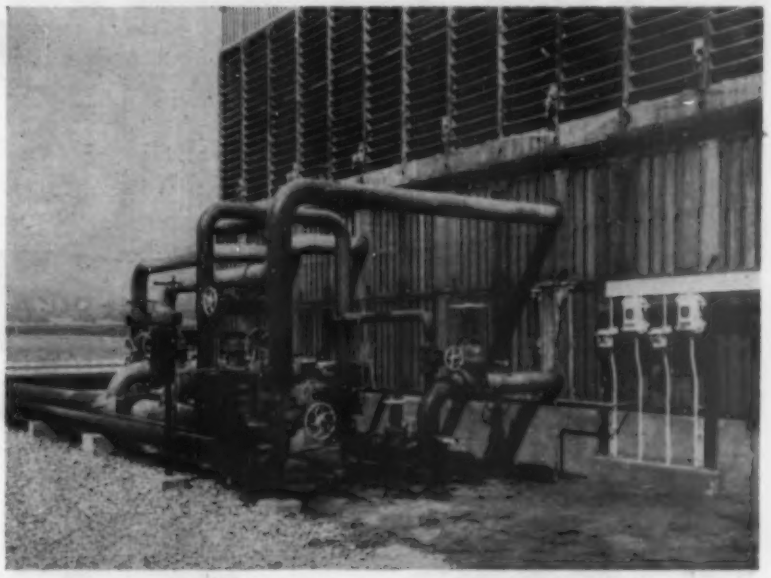
Instruments mounted on the main control panel in the office give the operators a complete record of gas flow and a constant indication of the main flow temperatures, pressures, and engine speeds. Running lights for all electrically energized units are mounted on the panel, as well as a complete alarm and emergency shut-down system. An emergency gas blow-down and plant by-pass system is installed with control stations at all strategic points in the plant.

A gas-engine-driven emergency electric generator is installed in the auxiliary room. This unit is capable of carrying the complete plant electrical load in event of a power interruption.

The latest gas transmission code requirements have been incorporated throughout the design and arrangement of the plant. These requirements, although eminently safe and practical, have in many instances effected economics not found in some of the former design practices. ★ ★ ★

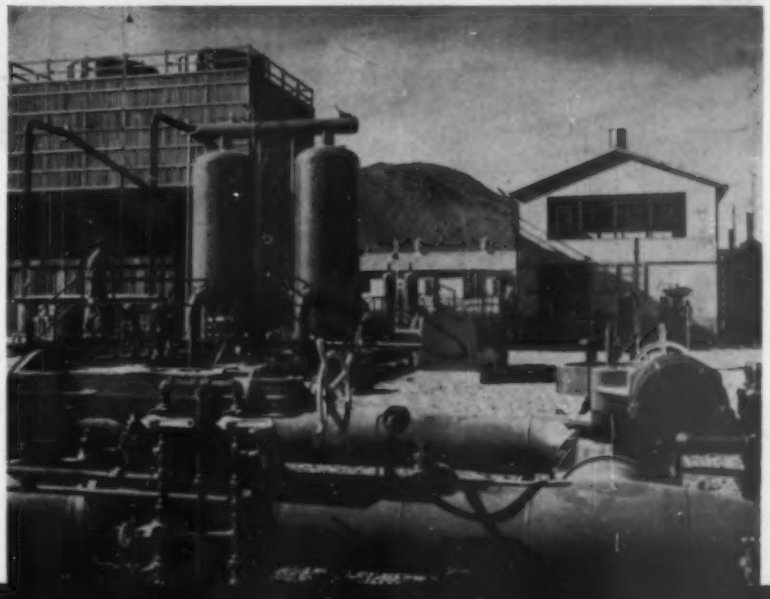


Gas intake and discharge manifold showing intake gas cleaners and automatic blow-down system, upper right. Blow-down stack can be seen at upper left.



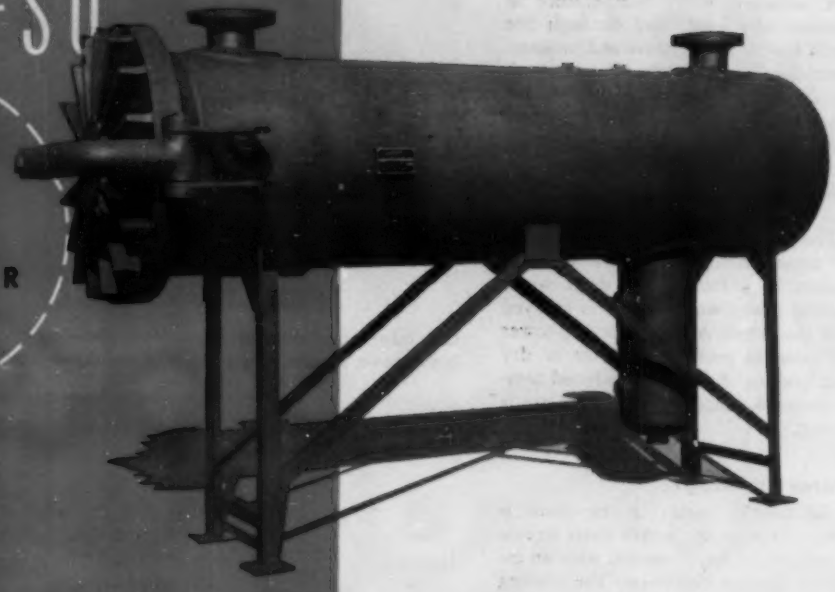
Transmission gas and engine jacket water lines at point where flows enter and leave atmospheric cooler sections in cooling tower. Jacket water flow control manifold is in foreground.

Close-up of intake gas manifold showing manual shut-down control at lower left.

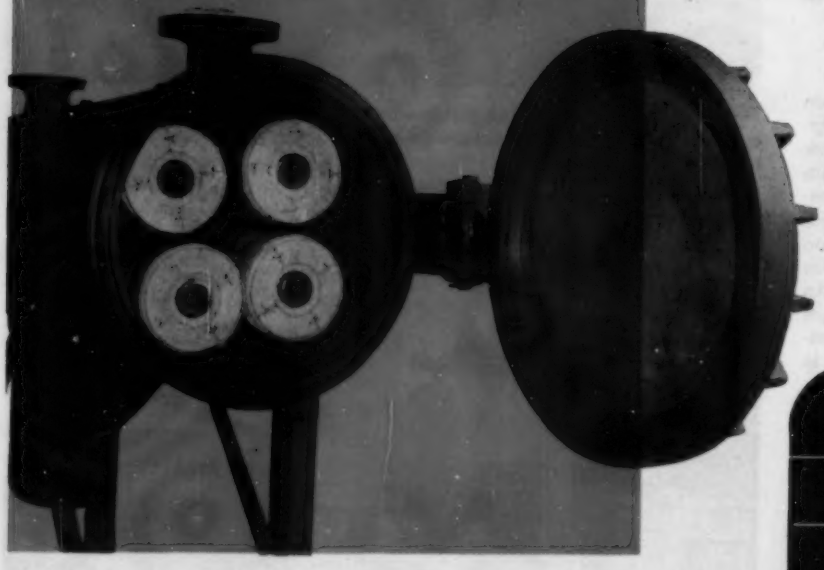


EXCEL-SO

HP-700
CLUSTER
REPACK
SEPARATOR
STRAINER



. . . the only high volume pipeline strainer that removes free water from petroleum products!



The HP-700 is rated from 750 to 1000 GPM on gasoline and fuel oil. The four repack cartridges provide a total filtering area of approximately 5,500 square inches. This Separator-Filter effectively removes solid particles down to forty microns in size. Equipped with quick opening closures and other easy service features, this compact unit is designed especially for the pipeline industry. Write for detailed information.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

DIVISION OF **FRAM** CORPORATION

API Sponsors School Of Pipe Line Technology

Preliminary plans for a School of Pipe Line Technology have been announced by the Division of Transportation of the American Petroleum Institute.

Its objective is to help insure the availability of qualified manpower to staff an industry that, in the next decade, is expected to witness far-reaching expansion.

This school will be operated by the Petroleum Extension Service of the University of Texas, in cooperation with Lee College, Baytown, Texas, and the Trade and Industrial Service of Texas Education Agency. It will be sponsored by the Institute's Transportation Division.

Present plans call for the school to open its Fall term around October 1, and its Spring term in February. Each term will be complete in itself, and will run six weeks.

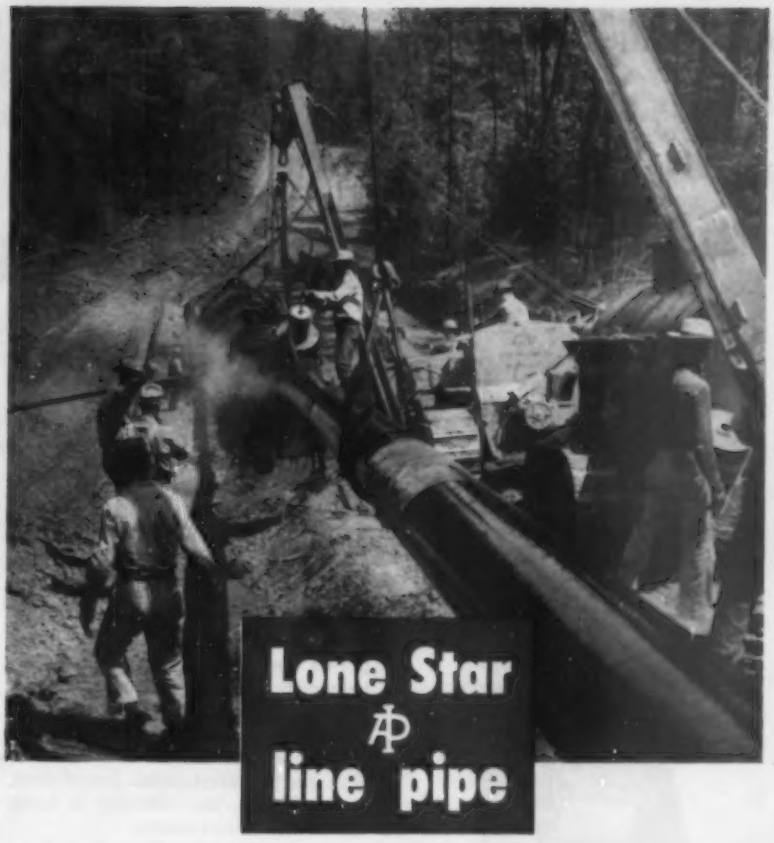
Enrollment will be limited to 30 persons, and the fee will be $300. Instructions will be given by outstanding specialists from the industry and universities. Lectures, demonstrations, motion pictures, exhibits, and field trips will be combined to make the course as effective as possible.

Topics to be covered in the six-week course include the economics and history of pipe line transportation, personnel organization, industrial and public relations, main line design and construction, main line maintenance, main line corrosion control, gathering systems design and construction, gathering systems operation and maintenance, scheduling and dispatching, communications, and reclaiming and salvage.

The API announcement said the school is planned primarily for pipe line supervisors and prospective supervisors. It emphasized: "In brief, the sponsors propose to establish a resident training center in the heart of the Gulf Coast petroleum shipping and processing area; to offer here a tightly-organized curriculum of six weeks of practical education on pipe line transportation; and to bring to the enrollees, as instructors, outstanding specialists from companies and from universities of the area."

Equipment Will Be Exhibited At NACE San Antonio Meet

For the first time in the history of the National Association of Corrosion Engineers an exhibition will be held at a meeting of an NACE Region. The exhibition of corrosion control materials and equipment will be concurrent with the San Antonio sessions of NACE's South Central Region October 23-26. About 50 exhibits are planned.



standard of the industry

in the Mid-Continent area

The huge, ultra modern Lone Star Steel plant was built primarily to serve the busy Mid-Continent area . . but week after week, pipe orders come in for tons of Lone Star API line pipe, casing and tubing to be used in distant territory.

From mining of the ore through Lone Star's precision pipe mills..Lone Star's API pipe quality is controlled in every step of manufacture. Lone Star line pipe has uniform wall thickness and roundness, is easy to field weld and easy to bend.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

Lone Star STEEL COMPANY

LSS

EXECUTIVE-SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12236 • Dallas, Texas

DISTRICT SALES OFFICES
Houston, Texas | Midland, Texas | San Antonio, Texas
Tulsa, Oklahoma | Wichita Falls, Texas | Shreveport, La.

Combination instrument reduces problems, makes easier the job of

Finding Buried Gas Leaks

J. P. Sherwin
Mine Safety Appliances Company, Pittsburgh, Pennsylvania

FIG. 1. Detection and measurement of trace concentrations of combustible gas in bar holes are greatly simplified in this combination instrument. An electrical range multiplying system utilizes both the combustion principle and thermal conductivity method without dilution technique.

EXCLUSIVE

FINDING gas leaks in underground pipe lines has been a problem of considerable economic significance. Although great progress has been made during the last 25 years in the development of gas detecting instruments, quantitative measurement, which is essential in finding the source of leaking gas, has often been characterized by uncertainties, loss of time, inconvenience, and difficulty in using the available instruments.

These limitations have now been largely overcome by combining two existing instruments into one. The combination instrument utilizes the combustion principle for detecting gas concentrations that are below the lower explosive limit, and the thermal conductivity method for measuring higher concentrations. The feature of this method is the use of separate sensing elements for the two ranges. This has eliminated the standard gas dilution technique and the necessity for an intermediate scale on which two widely different concentrations of gas may give the same reading. This means that a long sought objective, a simple and more accurate electrical range multiplying system, has been achieved.

First Major Improvement

It has been about 25 years since the first combustible gas indicators were introduced to replace flares over bar holes and flame tests on trapped bottle samples. This improvement over "fire tests" and earlier efforts to detect leaks by odor eliminated much guess work because these instruments could detect much lower concentrations of gas. Leaks that could not be detected before could then be detected and a search made for their locations.

Early in the application of these instruments it was recognized that, whereas combustible gas indicators were excellent detectors of leaks, their range of zero to 100 per cent of the lower explosive limit impeded their usefulness in tracing leaking gas to its source. Although a leak might be isolated to a section of pipe between the adjacent manholes where instrument readings were highest, this still left several joints as potential places from which gas might be escaping. The range of the instrument had to be greater to make it useful in checking bar holes driven along and over the pipe joints before the source of leakage could be fixed positively without making a number of expensive pavement cuts and excavations.

Diluters Introduced

This need, coupled with the knowledge of gas burner operations, led to the development of a quantitative method of diluting samples too rich in gas for comparative readings on available indicator scales. A variety of "diluters" emerged from these efforts. Dilution tubes, dilution valves, or range multipliers as they were sometimes called, were provided by instrument manufacturers so that field crews could pin-point leaks in buried pipe line before any of the pipe was exposed by excavation.

In general an effective job of leak finding has been done by these combinations of a combustible gas indicator and a dilution accessory; so much so that practically the entire gas industry has adopted the method. The limitations of this system can be readily understood, however, in considering the fact that the total flow of sample through the instrument is only 0.01-0.02 cu ft per min. Assuming a lower explosive limit of 5 per cent by volume for natural gas (slightly more for manufactured gas), higher gas concentrations require dilution with up to 20

FIG. 2. This detector has a single range switch or selector for its dual function. The on-off switch also operates a rheostat to adjust zero of both gas detecting and measuring scales. A separate zero adjustment (Z.A.) compensates for differences in resistances of two detector filaments after extended periods of use.

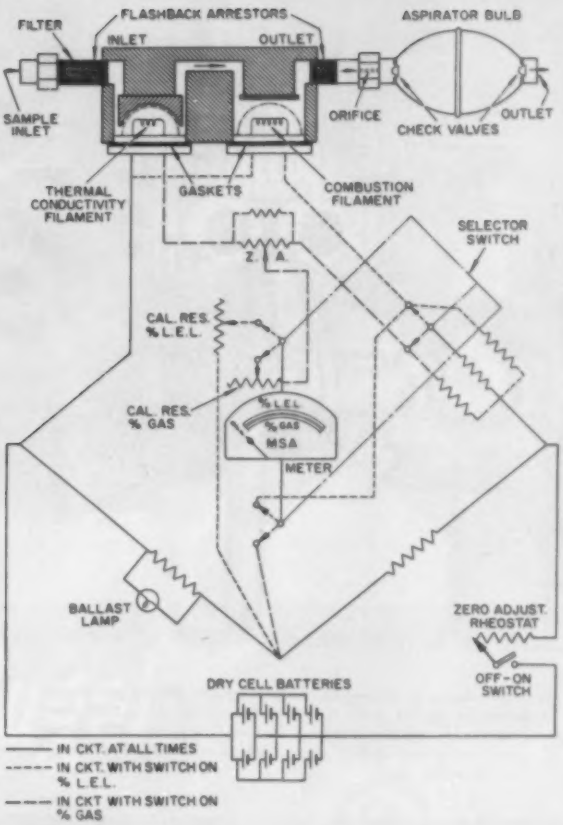


FIG. 3. In the Gascope, gas samples pass over separately activated thermal conductivity and combustion filaments in series. Bridge circuits for each filament are served by the same batteries and indicating meter, and have a common compensator side. A single selector switch makes all changes in connections between the two circuits.

parts of air for a sample that is 100 per cent gas in order to get an "on-scale" reading. This means controlling gas sample flows of the order of 0.0005 to 0.0010 cu ft per min through a fixed orifice with the pulsating suction provided by conventional rubber aspirator bulbs. Although the widespread acceptance of this method testifies to the fact that the combination works most of the time, the combination of all the various factors of operation requires considerable skill.

Free Flow Method

Another approach to the solution of the problem of locating leaks in buried pipes is the "pressure method" or "free flow method." In this method the combustible gas indicator is used with a sampling line and probe instead of its aspirator bulb and flow restricting orifice. The probe, surrounded by a plug, is inserted into a bar hole in such a way as to seal the hole. Development of gas pressure in the hole causes gas to flow through the probe and sampling line to the indicator.

By measuring the time from insertion of the probe until some finite deflection of the meter pointer at each of several holes, the location of the highest pressure that is nearest the pipe leak, is shown by the lowest time of increment. This method is uniquely adapted to testing in areas where the dilution system might give the same reading at several bar holes, as under a solid pavement where a large area is saturated with leaking gas. This method has never been generally accepted because it is slower than the dilution technique.

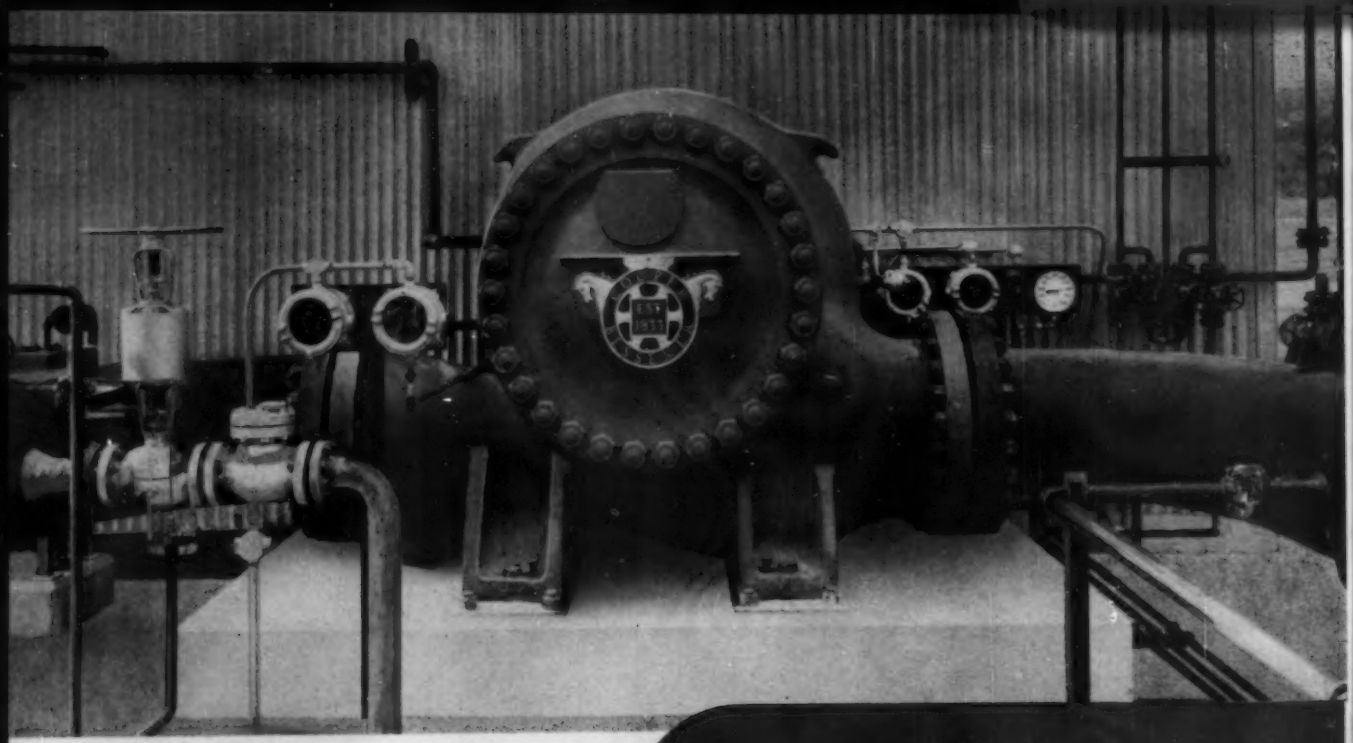
One of many efforts to improve these techniques was to modify the electrical circuit of a combustible gas indicator so as to provide for reversing the polarity of the indicating meter by the operator. This permits retaining the desirable high sensitivity of the basic combustible gas indicator for detecting trace concentrations of gas while using the reversing action of the meter to show gas concentrations by means of its thermal conductivity. This is done by using the higher heat conduction rate of the gas surrounding the detector filament as an index of concentration.

The limitation of this method is the fact that the filament's capacity to burn gas is the amount of oxygen available for combustion. It is this fact that gives an indicator so adjusted the peculiar calibration curve whereby two widely different concentrations of gas may give exactly the same reading. To eliminate this characteristic an intermediate range was placed between the scale of percentage of lower explosive limit and that for rich concentrations. This middle range requires the same dilution technique described previously, improved by a reduction of the maximum dilution ratio to approximately 10 to 1. Three-scale instruments with 5 controls to be manipulated and coordinated with readings on one of the 3 scales are widely used despite their complications for the average man.

Two-in-One Instrument

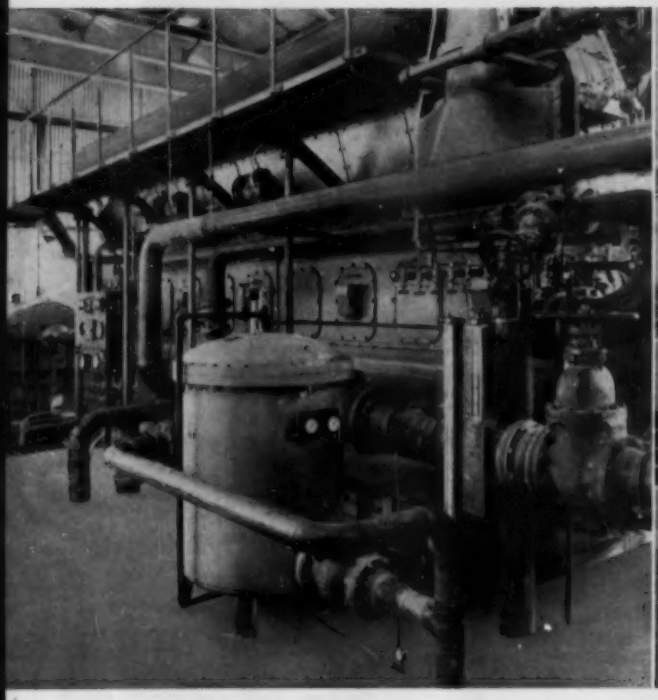
This combination instrument* was designed without sacrificing small size or light weight. Two bridge circuits are served by the same batteries and the same indicating meter, which is the largest single part of any portable combustible gas indicator. A single range switch makes the proper connections for batteries and meter, and serves a third purpose. It also provides for a

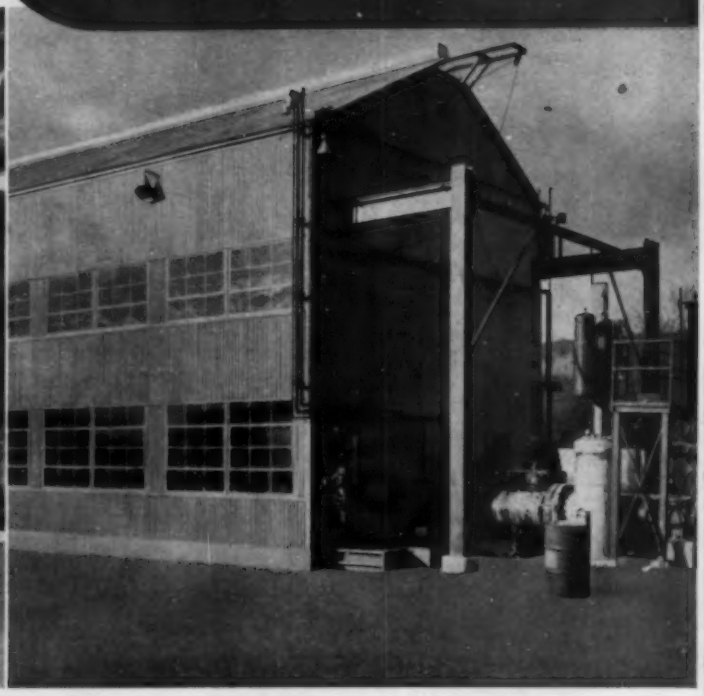
*The MSA Gascope, Model 53.



Cooper-Bessemer centrifugal compressor and 4-cycle gas engine, separated by fire wall, comprise unitized set-up in Gulf Interstate's new satellite station. Nominal capacity: 400 million cubic feet a day at 935 psi. Note compactness of station in view at lower right.

Cooper-Bessemer





COMPRESSORS Reciprocating and Centrifugal DIESELS
GAS ENGINES · GAS-DIESELS

Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle Tulsa Shreveport St. Louis Chicago

Another important FIRST in gas pipeline transmission

ENGINE-DRIVEN *centrifugal* COMPRESSORS

• A new chapter in the progress of gas transmission has been opened at Gulf Interstate Gas Company's new compressor station near Stanton, Kentucky. Here, a Cooper-Bessemer engine-driven centrifugal compressor, the result of long development, is the first such unit to go into regular service on a main gas transmission line.

This precedent is a tribute to Gulf Interstate management for alertness and decisive action in the application of promising new ideas . . . here successfully applied through the close cooperation of Gulf Interstate and Cooper-Bessemer engineering. These are a few of the highly significant features:

SATELLITE STATION . . . Designed and fully equipped for automatic, unattended, remote control operation—*another* "first" for Cooper-Bessemer engine-driven centrifugals.

IDEAL FLEXIBILITY . . . Combines continuous, heavy-duty performance with ability to meet peak demands. Greatly increases flexibility of line-to-market gas transmission.

EXTREME SIMPLICITY . . . Comprises a "unitized" setup not requiring separately operating auxiliaries. Moreover, the combination permits controls that cannot be matched for simplicity in satellite operation by most alternate methods.

UNMATCHED ECONOMY . . . With 41% thermal efficiency, the Cooper-Bessemer 4-cycle engine is unsurpassed in fuel economy by any other type of prime mover today. It would take 2 to 5 conventional compressor units and a much larger station to equal its capacity.

PROVED COMPONENT DESIGN . . . Actually the engine and other major components of this unitized set-up are *not new*. They are fully proved designs! It is the *combination* that sets an important precedent and brings new advantages!

Cooper-Bessemer engine-driven centrifugals offer identical or similar gains in various types of service. Additional installations are already under way. Why not discuss *your* plans with the nearest Cooper-Bessemer office?

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

New York City Washington, D. C. New Orleans Los Angeles and San Francisco

Cooper-Bessemer of Canada, Ltd.

11304, 119th St., Edmonton and 615 Second St., S. W., Calgary, Alberta, Canada

reduced flow of current through the combustion filament when thermal conductivity measurements are being made. This small current heats the filament almost up to the catalytic activity required for combustion.

To make it possible to switch from one bridge to the other without delay or adjustment the combination instrument has been designed so that the compensator side of the two bridges is common and the combustion filament is kept hot but below active heat while thermal conductivity measurements are made. Only the one switch is operated when changing from one range to the other. There are no valves to be coordinated with switch operation. Gas samples pass over both detector filaments, which are arranged in series in the flow system.

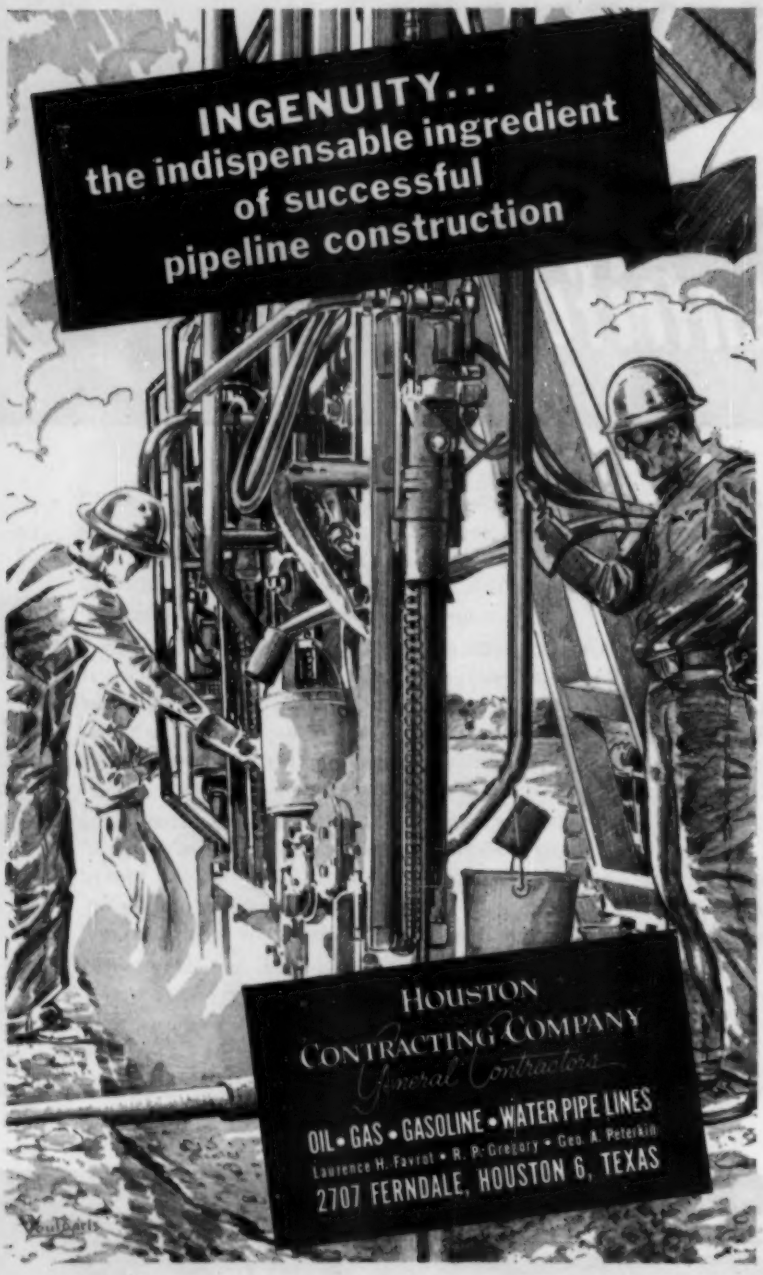
Two other controls are rheostats for circuit adjustment. The use of a common compensator side of the bridge circuit permits use of a single zero adjusting rheostat for both circuits. The second rheostat compensates for relative change in resistance of the combustion filament and the thermal conductivity filaments. This requires operation only about once in eight hours usage to establish and hold zero coincidence for both scales because the rate of change of the detector is small. It is thus possible in normal operation to switch from one scale to the other without readjusting the zero setting and to move rapidly along a line of bar holes, comparing concentrations without having to stop and readjust the instrument.

Other features in the design are the result of practical field experience. The lid protects the meter and panel when not in use and folds back flat against the back of the case so as not to obstruct the user's vision when moving over rough ground or walking near curbs and curb boxes. This lid cannot be closed until the battery is turned off. Spare filaments for both circuits, mounted internally, provide for immediate replacement upon any failure.

Instrument batteries are flash light dry cells because they are universally available. They are inserted through the bottom of the instrument so that there is no chance of disturbing the circuit components when replacing spent batteries. One set gives eight hours continuous usage. As a further precaution the lightweight die cast aluminum case has a solid partition separating the battery compartment so that if batteries should decay to the point of leakage, the battery fluid cannot contaminate the vital parts of the instrument.

The MSA Gascope was developed in the John T. Ryan Memorial Laboratory of Mine Safety Appliances Company.

* * *



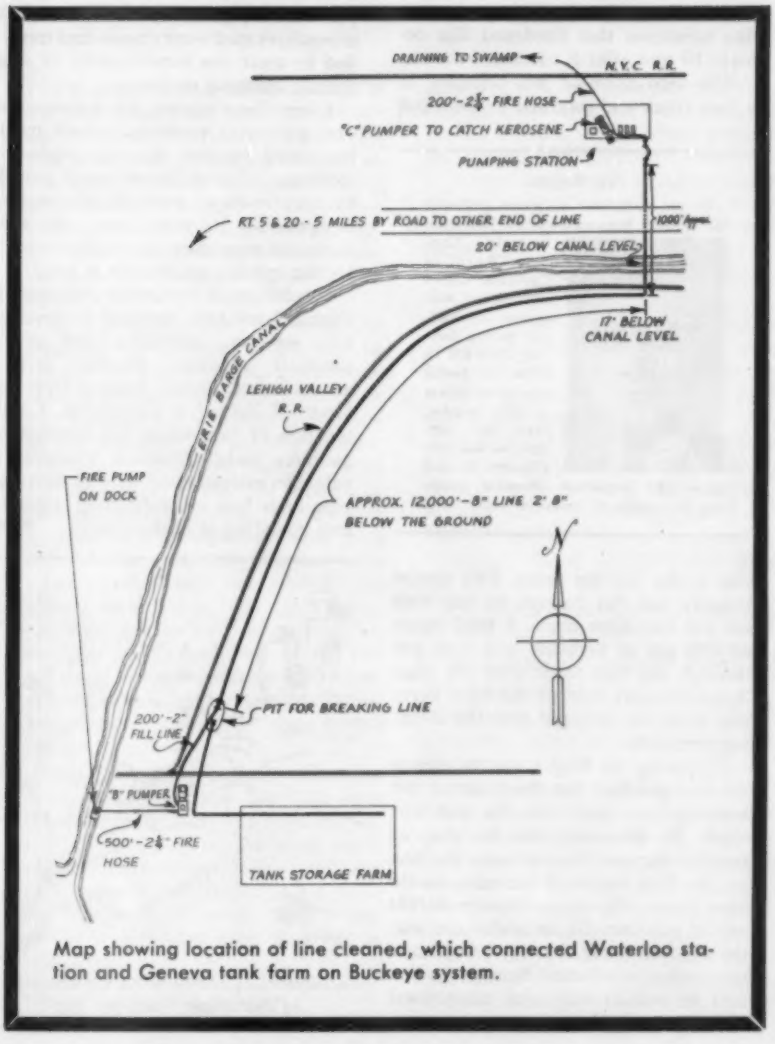
"Where did you get that pipe line crew? . . . From the telephone company?"

Regular maintenance program can keep lines free of obstructing deposits, increasing flow efficiency

Cleaning Pipe Lines With Chemicals

Harold R. Quinn
Dowell Incorporated

EXCLUSIVE



Map showing location of line cleaned, which connected Waterloo station and Geneva tank farm on Buckeye system.

ONE of the major headaches of pipe line operations is the deposits that accumulate on inner surfaces. These deposits reduce line capacity and may contaminate the product that the line is transporting. Unless remedial measures are taken, the line may become completely plugged.

If mechanical cleaning methods fail, a costly replacement has frequently been considered the only alternative in the past. Today, however, chemical solvents are extensively used for removing deposits. The importance of this method has been increasing for a number of years.

Chemical cleaning is especially valuable when performed periodically as a routine measure to remove deposits before their accumulation becomes critical. This method lends itself to such a maintenance program because lines are cleaned in place, eliminating the need for dismantling or long, costly shutdowns.

Sharp turns that prevent the use of mechanical scraping tools are easily negotiated by solvents pumped in to react with the deposit. The line is filled and the deposit is then allowed to soak, following which the spent solvent is flushed away, and the line inspected for cleanliness. Sometimes the solvent is circulated through the line. This technique speeds the reaction because solvent that has become spent is not allowed to remain in contact with the deposit.

In certain cases, filling the entire line with solvent is an uneconomical or impractical cleaning procedure. The line may be of such length or diameter that the cost of the solvent required to fill it would be prohibitive. The deposit may be comparatively insoluble in any commercial solvent or so thick that a lengthy soaking period would be required.

In such cases, auxiliary mechanical aids may be used advantageously in the chemical cleaning operation. A pipe line pig is frequently employed. Steel brushes scrape loose the scale as the

pig is forced through the line by solvents pumped behind it. A small amount of solvent jets through the nose of the pig in order to soften and loosen deposits for the brushes to remove.

This combination chemical-mechanical cleaning method effectively removed crude oil residual deposits from 13,000 ft of 8-in. line that was to be used to transport gasoline. The line connected the Waterloo pump station of the Buckeye Line Company of Emmaus, Pennsylvania, with a tank farm at Geneva. (See accompanying drawing.) The line was 2 to 8 ft below ground level and, where it crossed under a barge canal was 20 ft below the canal level. Reconditioned pipe was used in the line.

The pipe contained crude oil deposits that would contaminate any gasoline put through the line. Accordingly, removal of the deposits was essential.

An industrial cleaning service company was called upon and samples of this deposit analyzed by the service company laboratory. The paraffin deposit, a waxy film that was dark brown to black in color, was also found to contain some inorganic material, mostly iron oxide and a little debris. Laboratory tests indicated that the solubility of this deposit (at room temperatures) in kerosine was 45 per cent, in a chlorinated solvent was 42 per cent, and in Pyridine was 25 per cent. The solubility in a caustic solution (at 110 F) containing a detergent was 5 per cent.

Thus it was evident that an organic solvent would be most effective. Because of the large quantities of solvent required, however, a treatment was planned using the comparatively inexpensive caustic solution in combination with a pipe line pig. This decision was reached because it was felt that the caustic solution would loosen the deposit sufficiently for it to be removed by the brushes of the pig.

Cleaning Procedure

The line was broken at the south end so the pig could be inserted. An auxiliary pump was used to supply water from the barge canal to the service truck, where booster pumps provided the necessary pressure to force the pig and solvent through the line.

The line was broken at the other end before it entered the pump station. This was necessary because 90-deg turns in the last 150 ft would not allow a pig to pass. At the spot where the line was broken, valves were installed and an 8-ft piece of pipe attached to the valve to secure the pig after it had completed its run. Provision was made to drain the caustic solution and flush water into a swamp.

The pig was inserted, followed by 11,000 gal of the caustic solution containing detergent. Water was then pumped in at a pressure of 160 psi to force the pig through the line. The pig was designed to allow 20 to 30 per cent of the caustic solution to by-pass during its trip. Caustic solution began coming out the end of the line after 33,800 gal of fluid had been pumped.

A few small balls of wax arrived ahead of the pig, and the flexible rubber cups on the pig were found to be coated with wax. The pig was again inserted, and forced through the line in 4 hr and 8 min. It was apparent that the caustic was not as effective as had been anticipated.

The treating procedure was then modified to employ two pigs confining 1700 gal of kerosine between them. The by-pass openings in the pigs were sealed off.

Water was pumped for 4½ hr to force the pigs and kerosine through the line. A plug of removed deposits 8 in. wide and 10 in. long was forced out of the line by the first pig. Both pigs were found to be covered with a sticky tar-like substance that hardened like cement 10 min after it contacted the air.

The used kerosine was collected in a tank truck and returned to the input end of the line for reuse. This reused kerosine was run through the line with the pigs two more times. A fresh batch of 850 gal of kerosine was then put through the line twice with the pigs. Approximately half of the total kerosine used was salvaged after the cleaning operation.

Following the final stage the operator was satisfied that the color of the kerosine indicated that the line was clean. He estimated that the plug of paraffin deposits forced from the line by the first batch of kerosine would have been sufficient to discolor 40,000 bbl of gasoline. As an additional test, the operator's pig, having 4 cups and no brushes, was forced through the line in 1 hr and 10 min using compressed air.

The Author

Harold R. Quinn is service engineer for Dowell Incorporated, at Hamilton, Ontario, Canada. Born in Canada, Quinn attended McMaster University before joining Dowell in 1954. As junior service engineer at the Depew, New York, station, he has participated in and supervised numerous chemical cleaning treatments of industrial units.

Testing Considerations

The entire cleaning operation took 10 days. It is believed that under more favorable weather conditions the treatment would have required much less time. Temperatures ranged between 5 and 23 F. Thirty hours of treating time were lost due to valves, hoses, pumps, and pigs freezing.

Whenever the truck pump was shut down for more than half an hour, the hose and auxiliary water pump had to be drained to prevent freezing. Each night it was necessary to flood the pits at each end of the line and cover them with a wooden top and 2 ft of straw.

Calcium chloride, as an anti-freeze, was put in the pump, truck, and trailer tanks situated at the discharge end of the line. Even this precaution failed to prevent 2 in. of ice from forming in the bottom of the tanks.

Conclusions

This operation is an example of the application of chemical cleaning techniques to the problem of removing deposits from pipe lines. The solvents and procedures used were chosen and modified to meet the requirements of this specific cleaning problem.

Every line cleaning job presents its own particular problems, which must be solved by the cleaning engineer. Here, the value of "know-how," gained by experience of previous treatments, is apparent. In most cases, the solvents and procedures are "tailor-made" for the specific application at hand.

In addition, a continuing program of chemical research, designed to develop new solvents, inhibitors, and other chemical additives, provides faster, more efficient deposit removal from all kinds of industrial equipment. Combination of experience and laboratory facilities makes chemical cleaning a valuable maintenance tool in keeping pipe lines free of obstructing deposits and operating at peak capacity. ★ ★

"Quick! . . . Look what's happened to that pipe cleaning 'pig'!"

When Does a Corrosion Program Pay?

Economic evaluation of anything is dependent, to a great extent, on human judgment, but in choosing a corrosion control program there are certain rules to follow

Karl T. Feldman, *Part Interest Executive*
and
Ralph J. Osborn, *Assistant Chief Electrical Engineer*
Sinclair Pipe Line Company

FIVE and one-half billion dollars is the estimated direct loss from corrosion in the United States last year. To give some idea of the significance of this figure, it would be enough money to refund $100 to each person paying Federal Income Tax last year. The application of modern corrosion mitigation practices could greatly reduce this figure.

Sir Humphrey Davy set forth the principle of cathodic protection in 1824. It was more than 100 years, however, before the petroleum industry began studying the practical application of this principle. The use of protective coatings for pipe lines began at about the same time as the first interest in cathodic protection. One company constructed an 8-in. pipe line more than 200 miles long in 1928 that was completely coated with an enamel. An enamel little better than roofing tar, plus primitive methods of application, naturally led to a mediocre coating. The net result was concentrated and accelerated corrosion at holidays and subsequent leaks in a relatively short period of time.

This project was considered an economic failure because the field men reasoned "why spend the extra money and install a protective coating when we have had bare pipe in the same area for a considerably longer period without leaks." As a result of this and similar experiences there followed a period of time when the advisability of coating a new line was seriously questioned. In fact, a very small percentage of pipe lines was coated until 1940.

During this period the API was conducting coating tests at several selected sites. Considerable knowledge of protective coatings was gained by the entire pipe line industry as a result of these tests.

In 1930 and 1931 reports on cathodic protection began to appear in trade and technical journals. A report entitled "Relation of Pipe Line Currents and Soil Resistivity to Corrosion" was presented at the API Group Session on Corrosion of Oil Field Equipment on November 11, 1931, at Chicago, by C. R. Weidner. The bibliography of this report includes:

Speller's Book on Corrosion dated 1926.

Dr. Logan's paper on "Soil Corrosivity Surveys" dated 1931.

E. R. Shepard's research paper 298 dated April, 1931.

Gill and Roger's article "Electric Currents Carried in Lines" dated June 1930.

The report correlated long line currents and soil resistivities on an 88-mile section of 8-in. pipe line with actual pit depths measured along the pipe line. It describes the location of the areas of current discharge, the coating of a section of the line at the point of discharge, and the connection of a remote buried zinc plate. This, no doubt, was among the first field applications of cathodic protection.

"Hot Spot" Coating

Soon after this some companies began the practice of making soil resistivity measurement along the route of new pipe lines as a basis for the application of spot coating. This method of cathodic protection did lessen the total line currents but concentrated the current discharge on the area at the end of each coated section. It was at this stage of development (about 1940) that the pipe line industry began to realize the long term advantages of a 100 per cent coated line. During the period 1940 to 1950, the percentage of bare line laid was reduced to about 20 per cent of the total new construction and most of the bare pipe lines laid were short gathering lines of doubtful service life. From 1950 to 1955, the per cent of bare lines laid was further reduced to less than 10 per cent of the total.

Along with the 100 per cent coated lines, companies have installed galvanic anodes or rectifiers with good results. Several companies have records of operating a cathodically protected system for periods up to 10 years with no corrosion leaks.

Thus, the development of cathodic protection of pipe lines has progressed from infancy to its full blown development in less than three decades.

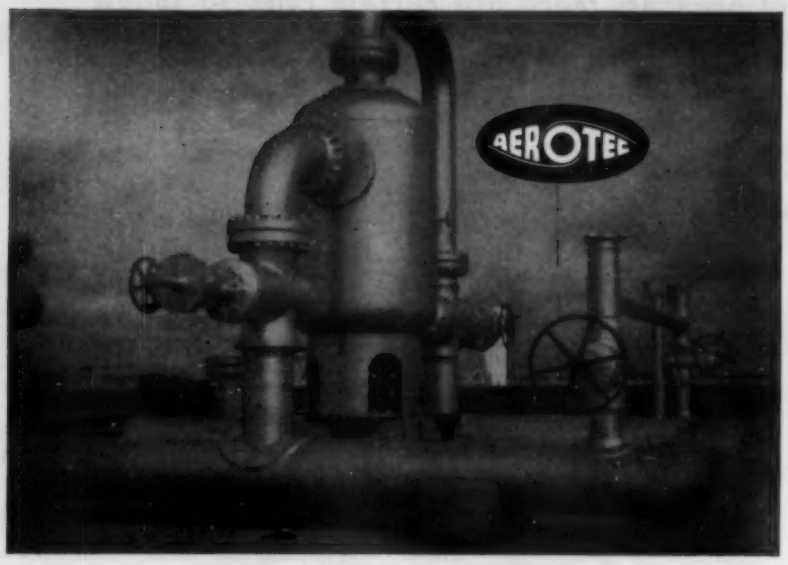
It was not until shortly before the second World War that internal corrosion began to receive much attention. The interest at this time resulted from the increased use of pipe lines for transporting refined products. Initially, water soluble chromates and sodium nitrite were used as inhibitors. During

Presented at Corrosion Control Short Course, University of Oklahoma, under the title, "General Economic Evaluation of Corrosion Control Programs."

war time, a patented compound called Rokon was widely used. Finally, in 1946, the first oil soluble inhibitor was successfully developed and put into use. Today, there are available inhibitors for successfully combatting internal corrosion from a wide variety of liquids.

Because pipe line companies have 70 per cent or more of their total investment in buried steel pipe it is only natural that they should be the leaders in developing and applying corrosion control practices; however, the same principles of corrosion control apply to many other industries. With the present understanding of the science and art of corrosion control there are many places where large savings are possible from its application.

There are few who feel that industry, even yet, has learned all there is to know about corrosion. However, practical techniques, instruments, and remedial measures have been developed to the point where it is possible to embark on a program of corrosion control with the assurance of accomplishing the intended purpose.



Here's a dry Gas Scrubber that will

take a 100% overload without loss of efficiency

Aerotec Gas Scrubbers enjoy a wide acceptance with leading pipeline companies. This recognition is the result of many advantages:

1. **Dry Delivery**
   Aerotec Gas Scrubbers deliver gas free from dust and liquid carryover. They employ no fluids in the scrubbing process.
2. **Overload Provision**
   Aerotec Gas Scrubbers will operate for a period at 100% overload without loss of efficiency.
3. **Compactness**
   These units are a fraction of conventional scrubbers in size.
4. **Manifolding**
   Aerotec Gas Scrubbers lend themselves to convenient parallel operation up to any capacity. Any unit may be removed from the line without affecting gas delivery.
5. **Simplicity**
   Aerotec units are simple in design and practically foolproof.

Why not check with our project engineers? They are experienced in methods of removing foreign matter from gas.

Project Engineers **THE THERMIX CORPORATION** Greenwich, Conn.
(Offices in 38 principal cities)
Canadian Affiliates: T. C. CHOWN, LTD., 1440 S. Catherine St. W., Montreal, Que.

Manufacturers
THE AEROTEC CORPORATION
Greenwich, Conn.

What Program Should Be Selected

The economic evaluation of anything is dependent, to a great extent, upon human judgment. This is particularly true of a corrosion control program. It is not something that can be weighed or analyzed in the laboratory; however, the economic evaluation of any corrosion control program can logically be broken down into four steps:

(1) A reliable estimate of the corrosion to be anticipated.

(2) An evaluation of the damages resulting from the anticipated corrosion.

(3) An estimate of the initial investment, operating expense, and effectiveness of various corrosion control plans feasible for the particular project.

(4) The selection of a program that will result in the greatest net return to the company.

Accurate Programs Important

Each of the steps mentioned rely heavily on statistics. Inaccurate or incomplete statistics tend to result in a wrong evaluation, so it is appropriate to emphasize at this point the importance of accurate records. If the methods of corrosion control are to be improved, information must be available to determine the cause of success or failure. The following information and records are an essential part of any long range pipe line corrosion control program:

(1) Record of the specifications of coating and cathodic protection installations.

(2) Leak record, showing exact location and other pertinent information about the apparent cause and result of the leak. This record should also show the amount and nature of the damages together with information indicative of the cost of repair.

(3) Record of test point readings taken periodically to show that cathodic protection installations are functioning as originally intended.

(4) Records of additional anodes or rectifiers installed to maintain desired level of protection.

(5) A record where possible of the condition of the line at the time it is taken out of service.

There are some who will wish to dispense with the trouble and expense of these records. Certainly there is a limit to the expense that may be incurred in maintaining these records. But their importance in evaluating future work must not be overlooked.

Estimating Probable Corrosion

Evaluation of the rate of corrosion is a specialized task for the technician;

however, it should be pointed out that time as well as rate of corrosion has significance in estimating the amount of corrosion to be anticipated. The only corrosion that has economic significance occurs during the useful life of a structure. If the refinery or producing area served by a pipe line has ceased to operate, a corrosion free pipe line has no significantly greater value than a badly corroded one.

Experience has shown that a large percentage of unprotected lines of any appreciable length is salvable even after 30 or 40 years of use. The petroleum industry has grown rapidly and many perfectly good pipe lines have required replacement merely because they were too small to be operated economically. In other words, corrosion costs nothing if it occurs on a structure that has no value. A line laid to gather oil from a group of wells with an estimated producing life of only five years might involve no significant damage by corrosion if the rate of corrosion was low enough. So one should keep in mind that other things than physical condition influence the useful life of any structure.

The second step in evaluation involves a dollar and cents value on the losses resulting from corrosion. In addition to actual cost of repairing the damage, this involves a number of contingent losses. In connection with a pipe line leak these obviously would include the cost of the oil or refined product lost as a result of the leak. This cost is one that may be fairly easily estimated, but the property damage resulting from this loss is much less predictable. If the leak occurred in cultivated land the farmer would have to be reimbursed for lost crops. If it is a crude oil leak in pasture land there will possibly be cattle losses.

Another problem becoming more serious all the time is the contamination of creeks and rivers from line leaks. In some instances, it may be necessary for a pipe line company to clean off creeks periodically for prolonged periods after a crude oil leak.

Of course, in the most congested areas the resultant damages and hazards are much greater than through rural areas.

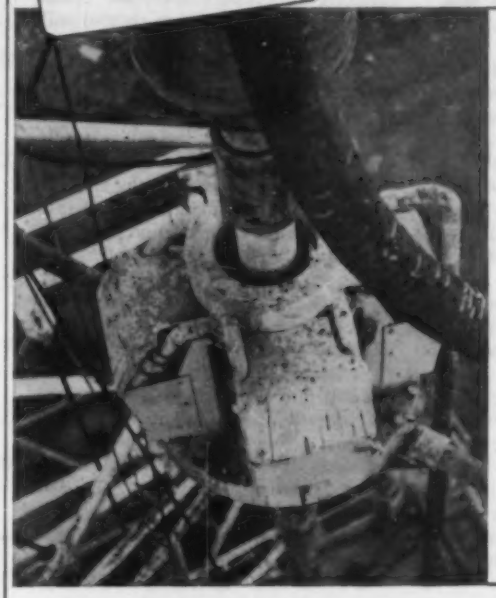
Some less obvious losses from corrosion include the loss of revenue resulting from the shutdown time necessary for repairs. This affects not only the company immediately involved, but also possibly other dependent concerns. In the case of a pipe line leak, the pipe line company may lose revenue due to the loss of throughput during time the line is out of service, and also, a refinery may have its operations disrupted if the leak is serious enough.

The mere possibility of corrosion

493

COST CUTTING CASE STUDY

BERRY®
Hydraulic Units



New Drilling Method Uses Berry Units because:

- *Oil Field Reliability Proved*
- *Maximum Torque at Stall*
- *Infinitely Variable Speed*
- *Smooth Operation at Low Coring Speed*

Four Berry Hydraulic Motors mounted inside housings on drilling sub give rugged and dependable service.

PEMBINA CORING COSTS CUT 26%
with revolutionary BERRY-powered drilling sub

In the Pembina area south of Edmonton, Alberta, some way had to be found to take an uninterrupted core. Small iron was damaging the diamond core heads when drillers broke off the core and pulled out to make a connection.

A drilling sub, powered by Berry Hydraulic Motors was developed which makes possible continuous coring with minimum core damage from small iron because the bit never leaves the cutting surface.

Berry Hydraulic Motors develop the high torque required in this operation. Mounted around a ring gear, four Berry Motors directly drive the drill pipe at infinitely variable speeds from 0 to 135 rpm. *Power oil for the sub is supplied by "packaged" Berry Hydraulic-Pumping Units.*

The Berry-powered sub eliminates rotary tables, Kelly joints and rat holes. It has reduced average coring cost from $38.00 to $28.00 per foot . . . a saving of 26%. Diamond bit cost has been reduced an average of 37.5% with the new drilling sub.

Advantages gained: Rotary Tables and Kelly Joints Eliminated • Complete Core Recovery Without Removing Bit from Bottom • No Expensive Rat Holes are Needed • Continuous Coring is Possible • Coring Costs Reduced 26%

Want the full story on Berry Hydraulic Units?

Write for descriptive literature and catalog showing complete specifications on Berry Motors and Pumps for oil country use.

BERRY DIVISION
OLIVER IRON AND STEEL CORPORATION
PITTSBURGH 19, PA.

damage may have a direct bearing on operating expenses. As leak frequency goes up on a pipe line, it becomes necessary to space maintenance gangs at closer intervals in order to reduce the time required to make repairs.

A recent survey of 28 pipe line companies showed that an average leak costs from $130 to $2500 each. One company reported 1602 leaks at $750 average cost or a total of $1,201,500 per year. This company was operating 9000 miles of line only 30 per cent of which was cathodically protected and most of it was bare. Twelve of the 28 companies reporting showed 100 per cent of their lines cathodically protected, and 8 of these showed that no leaks occurred during the year.

Figures such as these are of value in estimating losses resulting from corrosion but it must be emphasized that each case calls for specific consideration. The potential losses of the job in question must be considered rather than the average. A products pipe line on the eastern seaboard passing near metropolitan areas and exposed to excessive interference from adjacent buried structures may warrant a more expensive coating job than a line laid through some of the arid, sparsely populated areas of the Southwest.

Estimate of Costs

The procedure for estimating the cost of various corrosion control measures, as required for the third step in evaluation, is a specialized subject that will not be dealt with here. As a preliminary to the final step in evaluation, however, it should be pointed out that attention should be given to the accounting procedures involved. Some expenditures for corrosion control will be classed as investment and some as operating expense. It is often necessary to obtain the opinions of the accounting department to classify these expenses properly. For instance, sacrificial anodes installed during the initial construction of a pipe line may be capitalized as an investment, but the same anodes installed after the line is once in operation are charged as maintenance. Rectifiers and their ground beds may be capitalized regardless of when they are installed.

It would seem that when a figure has been arrived at that represents the dollars lost due to corrosion, and another that represents the dollars a program will cost to prevent this loss, it is merely necessary to subtract to find how much "profit" is to result from a corrosion program. Basically this is true, but there are certain complicating factors that may still influence the decision.

If investment capital is short, it may be desirable to minimize the initial or investment cost in order to free cash for investment in other profitable ventures. Necessarily when this is done, higher operating expenses result either from more corrosion losses, more rectifier power consumption, or shorter life of sacrificial anodes. On the other hand, there may be economic factors that call for a minimum operating expense. In this event, it would probably be desirable to invest a larger amount for such items as high quality coatings, rectifier ground beds of extremely low resistance, and large size sacrificial anodes.

Conclusion

Up to now, many cathodic protection programs have been evaluated to this extent. There are perhaps too many intangibles involved to arrive at as precise an evaluation as has been indicated, but a logical approach is essential to the overall evaluation of any corrosion program.

Corrosion control should conform closely to the law of diminishing returns. The first dollar spent for a specific corrosion control program should yield the greatest return. Each successive dollar spent yields a smaller return until the breakeven point is reached.

The corrosion engineer shares with management in the responsibility for seeing that the corrosion control program does not go beyond the breakeven point in striving for technical perfection. ★ ★ ★

Here it is-from **CINCH**

NEW VERTICAL HYDRAULIC PIPE BENDING MACHINE

It's the **only vertical hydraulic** pipe bender in the business . . . designed to save you time and money on the line. It's lighter . . . more compact . . . and faster. Since it's not overweight, overheight or overwidth it can be easily and quickly transported on float truck without removal of tracks.

Two sizes: 16" through 30"; 22" through 36". Already proven in field on 36" line over rough terrain in Georgia and North Carolina. You must see the new Cinch Vertical Hydraulic Pipe Bending Machine in action to appreciate its time-cutting, money-saving benefits.

It's a Cinch...Cinch Machines are used by the leading Pipeline Contractors.

CINCH
PIPELINE EQUIPMENT, Inc.

7020 Long Drive Phone: MI 5-2484
Houston 17, Texas

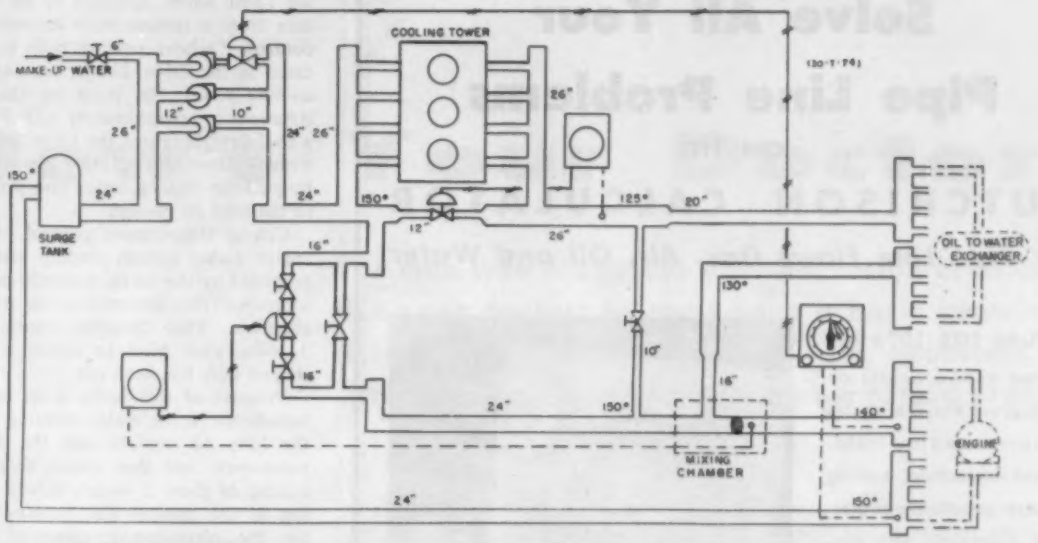


FIG. 1. Piping diagram of combination cooling system using differential temperature controller.

Cooling System Control

Unique differential temperature control system at compressor station eliminates one surge tank, several pumps, and provides savings in piping and building space

BECAUSE of the amount and importance of cooling water in compressor station operations, engineers of Tennessee Gas Transmission Company have made exhaustive studies of compressor jacket, engine jacket, and lube oil cooling problems. A conclusion reached is that temperature differential across the engine and compressor jackets is just as important a factor as the average temperature of the water in the jackets.

In using temperature differential as the controlled variables, expansion and contraction of the metal in the engines is lessened, and wear of parts is thereby decreased. In addition, the chances of seized pistons and cracked cylinders are greatly lessened. As a result of these investigations, a unique method for cooling water circulation and temperature control has been developed and placed in operation in several stations along the line.

The differential temperature control system used in compressor stations has many advantages. As illustrated in the piping diagram, the method uses a closed water system that combines cooling of engine lubricating oil and engine jackets. With this closed combination arrangement, surge tanks and additional water circulation pumps, which would be necessary with separate systems, are eliminated. Thus an important saving in building space and piping is realized.

Beginning the cycle of operations at the surge tank and pumps, it can be seen that cooling water is pumped to a 24-in. header where it divides into 3 parts, 1 part going to the cooling tower, another through the 12-in. diaphragm motor valve by-passing the cooling tower, and the third part going directly to the 16-in. jump-over and motor-operated butterfly valve.

EXCLUSIVE

The quantity of water flowing through the cooling tower is therefore governed by 3 automatically controlled factors:

1. The total capacity of the circulating pumps.
2. The opening of the 12-in. by-pass valve.
3. The opening of the 16-in. butterfly valve.

These factors, in turn, are regulated

Solve All Your Pipe Line Problems

ON THE

HUTCHISON CALCULATOR

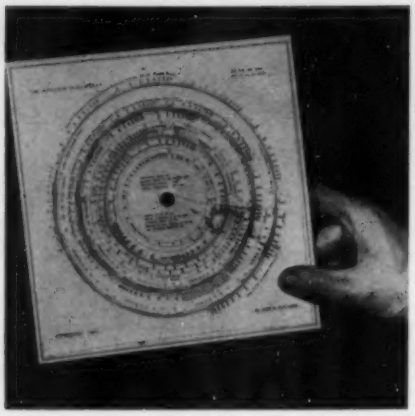
For Pipe Line Flows Gas, Air, Oil and Water

ACTUAL SIZE 10" x 10"

Printed in two colors on warp-proof Vinylite; scales are protected by transparent lamination, making erasure practically impossible. Complete with protectors, pressure table and instructions . . .

$10.00

Copyrighted 1950



Quick, Accurate, Easily Operated

Solves Problems In:

(1) High pressure gas pipe line flow by
  (a) Use of the Panhandle Formula or by
  (b) Use of the Weymouth Formula

It will correct for the specific gravity of gas

It will correct for pressure base in gas problems

(2) Low pressure gas pipe line flow by the use of the Spitzglass Formula

It will correct for interval distribution in high or low pressure gas or water systems

(3) Simple oil flow by National Transit Formula

It will give hourly or daily results for gas and oil

(4) Flow of water in pipe lines by the use of the Spitzglass Formula

It will solve many special problems easily

CLIP THIS AND MAIL TO:

THE PETROLEUM ENGINEER PUBLISHING COMPANY

Post Office Box 1589 • Dallas 21, Texas

Gentlemen: Please send me the Hutchison gas, air, oil and water flows calculator.

☐ $10 payment enclosed ☐ Bill me ☐ Bill company

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

by individual temperature controllers. Coarse system control is provided by the 12-in. valve, actuated by air pressure from a remote bulb temperature controller whose sensing bulb is located in the 26-in. header leaving the cooling tower. Set point on this instrument is approximately 125 F. On a cool day, therefore, the 12-in. by-pass would allow more 150-deg water to by-pass the cooling tower and proceed to the lube oil coolers.

Coarse temperature control of the engine jacket system cooling water is provided by the 16-in. butterfly on the jump-over that connects to the mixing chamber. This chamber contains a 3/16-in. steel plate in which a star-shaped hole has been cut.

Purpose of this baffle is to induce turbulence in the water entering from the lube oil coolers and the 16-in. jump-over, and thus insure thorough mixing of these 2 waters before passing to the engine. The sensing bulb for the recording temperature controller is placed on the downstream side of the baffle plate.

Water from the 16-in. jump-over enters the mixing chamber at 150 F and water from the lube oil coolers enters at approximately 130 F. The instrument maintains its set point temperature of 140 deg by varying the amount of 150 deg water from the jump-over.

12 Degrees Difference

To provide very close control of the actual temperature differential across the engine, a special differential temperature potentiometer[1] is used, with control set for a 12-deg differential. Reference temperature of the instrument is set at 140 deg, which is the nominal temperature of water entering the jackets from the mixing chamber. The 12-deg temperature difference is maintained by first having the system stabilized by the 12-in. by-pass and 16-in. jump-overs, and then by throttling over-all pump capacity by varying pressure on the diaphragm motor of the valve in the discharge riser from 1 of the circulating pumps. In this way, varying the rate of circulation of the water, which has a stabilized temperature, provides very fine control.

In a few of the compressor stations using the differential temperature method of control, the instrument has been equipped with high and low alarm switches set to sound an alarm if the temperature difference goes below or above the predetermined value by about 10 F. For other alarm purposes, a non-indicating pressure controller can be employed to warn of excessive water pressure or lack of water flow in the cooling system. * * *

[1]ElectroniK.

P 615.635

EXCLUSIVE

How's Your Doctor?

The man who diagnoses your corrosion problems is like your doctor: he must have a basic knowledge, a thorough understanding of your problems, and extensive experience in solving corrosion problems

O. C. Mudd
Consulting Corrosion Engineer,
Alpine, Texas

PROGRESSIVE industries recognize the need for greater efficiency and the extension of useful life for humanity and its material creations—if success in competition is to continue.

Every capable executive seeks to retain personnel free of afflictions that might impair an employee's specific abilities or retard that of his associates.

There is a growing trend in industry towards adopting preventive medical care for personnel, particularly in the executive group, to insure better efficiency, and thus allow early detection of disorders before their effects become serious and reflect adverse results through the organization.

This growing interest in maintaining humanity's well being is commendable; however, the best efforts from personnel can be realized only when recognized hazards, or causes of apprehension, are eliminated, while continuing effective maintenance of structures and equipment.

Impairment of structures or equipment eventually leads to loss of efficiency and creates hazards. Some impairments may go undetected until failure occurs, but such occurances manifest poor or inadequate maintenance.

Corrosion is one of the most frequent causes of structure or equipment impairment and failure. It is analogous to the effects of diseases on humanity —it often lowers efficiency, causes periodic "loss of work," and eventually terminates usefulness.

Ravages of corrosion may originate from the complexity of chemicals in nature, from those compounded by man, from thermal stresses, pressure stresses, electrical forces, and other less defined sources. Hence, variations and combinations lead to numerous types of corrosion causes, and any results obtained in mitigation or success in prevention depends upon the knowledge and experience available.

Proper diagnosis leads to more effective methods of cure; thus those having more extensive knowledge can obtain better and more immediate results.

It would be a rare occasion for an executive impaired by some affliction to seek the advice from other than those known to be qualified, and he would be most likely to consult the doctor most familiar with his past medical history. The doctor's past experience with his prior afflictions and responses to treatment offers advantages in each subsequent case.

In some cases, the doctor may solicit the aid of a specialist, in which case he seeks the assistance of one having more extensive experience, in a particular field of practice to obtain better treatment response.

It is apparent that better results are possible in corrosion control where those delegated to the work can acquire a knowledge of their potential problems, and be allowed time to get acquainted with many of the recognized causes.

In general, those with more extensive knowledge should have advantages in the detection of causes, and realize better methods of mitigation. Each experience in solving a problem gains advantage in coping with ensuing ones.

Basic science requirements for those following corrosion work include chemistry, electricity, metallurgy, and physics. Those adverse to hard work and getting their hands dirty are poor candidates because much valuable experience is gained only by "visiting the patient," and corrosion often occurs where access is difficult and the surroundings are not inviting.

Continued success of those engaged in corrosion control depends upon ever increasing their knowledge by study, broadening their experience by keen observation in their work and by association with others to share interests of mutual benefit.

Experience contributes a substantial if not a major part in the recognition of corrosion causes and effective methods of mitigation. It is obvious that continuity of experience through adequate training of successors will pay dividends.

Few, if any executives would seek the advice of a medical graduate before serving internship—because he knows that experience, along with study of various cases, develops ability to cope with each new case.

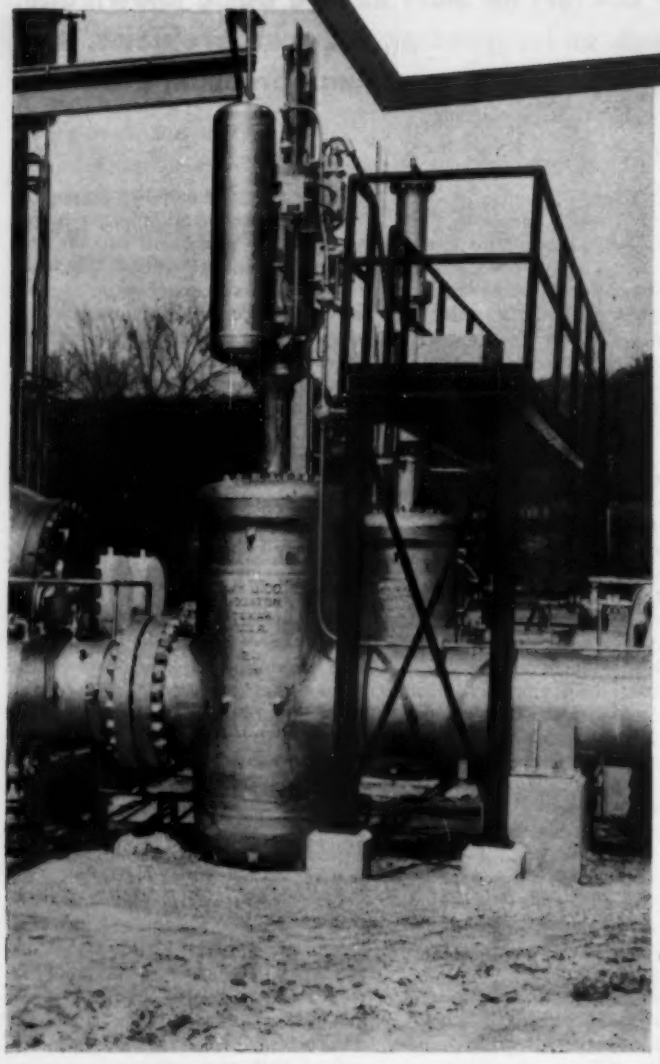
Continued advancement in any profession depends upon study to keep abreast of new techniques and discoveries, and those attaining success in corrosion work must follow such a pattern.

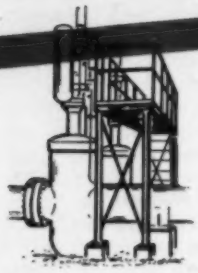
Qualified personnel must be capable of soliciting cooperation of others and extend cooperation where needed. Information obtained from operating personnel often leads to the detection of new corrosion causes, such as changes in process, changes in operating procedure, changes in commodity handled and similar deviations considered of little consequence by the operators.

Corrosion causes may alter and their remedial measures be nullified where processes, commodity handled, or other environmental changes occur, making it essential to maintain adequate surveillance over remedial or preventive measures, making revisions

W-K-M *Dependability...*

VITAL IN GULF INTERSTATE'S FULLY AUTOMATIC COMPRESSOR STATION





Completely dependable valve operation is of the utmost importance in this remotely controlled, fully automatic compressor station. These valves, operated from a station 80 miles distant, must open or close at the push of a button. The parallel expanding gate in W-K-M valves is the best possible insurance for dependable operation. Before moving into open or closed position, the gate segments are positively contracted by the exclusive LEVERLOCK and held in this position, assuring free and easy movement of the gate. Expansion of the gate segments against both upstream and downstream seats provides a positive double seal. Their Through-Conduit provides full volume, free flow . . . offers no more pressure drop than an equivalent length of pipe . . . sets up no turbulence. The right ratio of port opening to closing speed prevents dangerous line surges.

For the ultimate in dependable performance with minimum maintenance all along the line, specify W-K-M Pipeline Valves. Write today for your copy of the new W-K-M Pipeline Valve Catalog 300.

W-K-M 24" ASA 900 Pipeline Valves on suction and discharge lines of station.

W-K-M MANUFACTURING COMPANY, INC.

A SUBSIDIARY OF acf INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS
MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

MANUFACTURERS OF

W-K-M THROUGH-CONDUIT GATE VALVES

acf LUBRICATED PLUG VALVES

KEY RETURN BENDS AND FITTINGS

5608

when needed to restore effective control.

Those engaged in corrosion work must be capable of reckoning costs to prove the value of their efforts; hence, there is need for cooperation with those in accounting work, and they must also maintain records of their investigations, remedial measures and establish evidence to substantiate results.

Corrosion can cause variations in profit, and since profit is essential to competitive industry's survival, it is logical to consider what is good economy in corrosion control. Intelligent evaluation of corrosion losses can be established only after maintaining appropriate cost records over sufficient periods of time to establish definite trends. From an established trend it is possible to determine the probable limits of profitable mitigation expenditures.

In numerous instances, the cost of initial measures curtailing corrosion will effect a greater degree of control than subsequent expenditures; in other instances the degree of control may be near equal for each increment of mitigation cost.

With either of the above, a point is reached where the cost of mitigation measures equal, or exceed the losses entailed by the remaining unmitigated corrosion.

This application of diminishing returns can be determined from adequate records; however, other losses originating from corrosion may seldom, if ever, appear in such records.

Some of these are as follows:

(1) Personal injury or fatality.

(2) Property damage.

(3) Curtailment of production.

(4) Public ill will.

(5) Customer inconvenience.

These items need evaluation as they may apply to each problem, and their consideration may justify further expenditures to reduce corrosion below that level determined by diminishing returns.

Corrosion personnel having the ability to cope with their problems and reckon costs will have severe limitations unless they can render comprehensive reports that justify their efforts. They must acquire the ability to render such reports in as simple and few words as possible, yet contain all the essentials necessary in conveying the desired information to those receiving it.

The Author

O. C. Mudd was retired from Shell in 1955 after 25 years service and now resides at Alpine, Texas, doing occasional consulting work. Back in 1933 he was transferred from Shell's Wood River, Illinois, refinery to Shell Pipe Line Corporation. His duties were to assist in the first organized corrosion investigation on Shell's pipe line system. He has followed this field ever since and has pioneered many advancements. He has advised on corrosion problems in many parts of the world. He was born in Butte, Montana. He studied electrical engineering at Montana State College until 1917 when he entered military service. After the war he joined Montana Power Company and was assigned to various duties in operation and construction. In 1925 he was superintendent of construction for a contracting firm and in 1928 he joined Shell.

Too many engineers include technical details in reports that have little or no bearing on the objective, and this often leads to confusion. Management is interested in a brief of what has been done to accomplish results, but most of all they are interested in the extent of results and the benefit to be gained by continued efforts.

Management should be most interested in corrosion prevention efforts, i.e., those measures that are successful in preventing corrosion losses before they occur. This type of effort has to be considered from a view point differing from corrective measures.

Justification for preventive measures must be based on an organization's past experience, or the recorded experience of others. The amounts to be expended for preventive measures must be evaluated by comparison with that required to stop corrosion of similar structures, and also consider any increase of risks on new structures, or equipment.

A well qualified corrosion man, experienced in similar problems, should advise on such preventive provisions included in new projects if effective measures at minimum cost are to be obtained. It is far preferable that this man be one of the operating organization since he will have a direct interest in results.

When solicitation of professional assistance outside the organization is necessary, management should give the same consideration as he gives to his doctor, and investigate the accomplishments of those considered, and determine if their quotations for services or proposed installations are fair or unreasonable.

Management should also impose the necessary terms of contract on such professional assistance as will insure adherence to company policy, thus minimizing unwanted involvements with others after their contract is terminated.

The employment of corrosion personnel in an organization depends upon management's decisions, and such decisions should be made only after weighing the evidence and facts regarding current corrosion costs and indicated future trends.

In summary it can be stated that the maximum benefits in corrosion control can be realized only when those engaged in the work are interested employees having the basic knowledge, they have acquired a thorough understanding of their problems and most of all gained extensive experience in the successful solution of these problems. This experience includes more than corrosion control; it also includes personal problems, acquaintance with accounting, a knowledge of operations and often includes phases of company policy where problems involve others.

Successful corrosion engineers have advanced in their organizations to more responsible positions and they are an asset to their management because of their previous experience and continued alertness in being able to understand how to minimize corrosion losses. ★ ★ ★

"Thanks, fellows!"

Outstanding Convention Looms for AGA

Nationally-known speakers will address the 39th Annual Convention of the American Gas Association in Atlantic City, New Jersey, October 15, 16, and 17, according to Ronald A. Malony, president, The Bridgeport Gas Company. Three general sessions meetings of the five sections of the association and a home service breakfast and round table session will be held during the three-day meeting.

A highlight of the convention will be the special luncheon and business meeting devoted to a dramatic presentation on the progress being made in the development of gas all-year air conditioning equipment.

Several capable and qualified speakers from this important field will discuss market potentials and competitive activities. In addition delegates will hear a thorough and comprehensive review of the research and development activities of seven major manufacturers currently producing gas all-year air conditioning equipment.

Plans are in the making that will assure one of the most outstanding conventions in the history of AGA, the general convention committee declares. Malony is chairman of the committee and he is assisted by the following members: Walter E. Caine, Texas Eastern Transmission Corporation; J. F. Donnelly, Sr., A. O. Smith Corporation; C. B. Dushane, Jr., American Meter Company; H. A. Eddins, Oklahoma Natural Gas Company; Ralph W. Fouse, Brooklyn Borough Gas Company; W. T. Jeff, The Hartford Gas Company; O. H. Ritenour, Washington Gas Light Company; Michael E. Shea, Lynchburg Gas Company; Charles G. Simpson, Philadelphia Gas Works Division of the United Gas Improvement Company; John Tuohy, Long Island Lighting Company; Raymond J. Vandagriff, Laclede Gas Company; Hugh L. Wathen, South Jersey Gas Company; Tom H. Wheat, Transcontinental Gas Pipe Line Corporation, and Frank H. Wright, Southern Counties Gas Company.

FIRST

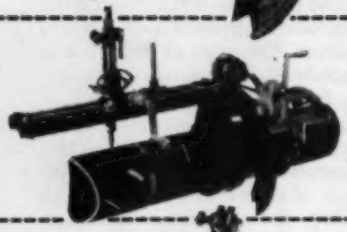
Choice for Pipe Cutting and Beveling Equipment

Mathey

PIPE CUTTING & BEVELING

Quick, easy operating. Just slips over pipe, no hinges or latches to open or close. Light weight reduces fatigue factor. Clean, accurate cuts.

Sizes 1 to 5 for Pipe 4" to 36" diameter. No. 5 machine available with optional closed gear section, insertable after pipe machine is slipped over pipe.



SHAPE & COUPON CUTTING

For cutting pipe to weld angular intersections to job requirements. Coupon cutting for welding analysis. Easily operated.

OUT-OF-ROUND ATTACHMENT

For accurately cutting out-of-round pipe, maintaining interval between torch tip and out-of-round pipe insuring clean, accurate cut.

for SPEED, ACCURACY, DEPENDABILITY, SERVICE AND ECONOMY—IT'S MATHEY

C. A. Mathey MACHINE WORKS, INC.

212 SO. FRANKFORT TULSA, OKLA. • PHONE Diamond 3-3623

Original manufacturers and engineers of all Mathey type Pipe Cutting and Beveling machines.

D-54

Trans Mountain Awards Contract for Pump Station

Trans Mountain Oil Pipe Line Corporation has awarded the contract for construction of its crude oil pump station at Laurel, Washington, to Engineers Limited Pipeline Company, of Seattle. In keeping with the corporation policy outlined to the Bellington Board of Trade last January, Engineers Limited has arranged that local contractors will undertake a large part of the construction work on this station.

El Paso Natural to Install New Equipment at Navajo

New facilities and equipment at El Paso Natural Gas Company's Navajo Compressor Station will include five new Worthington angle gas engine compressors.

Four of the new compressors are UTC-1610, 2000-hp units and one of the engines will be an SUTC-1610, supercharged type design.

According to H. C. Bartn, manager of gas transmission section, Worthington engine sales department, this latter engine will represent the first installation of its type for gas pipe line service.

The Navajo Station, which is situated at an altitude of 6500 ft, will necessitate a deration in sea level rating of these engines, so that as far as additional horsepower is concerned, four of the Worthington UTC-1610 engines will be rated at 2000 hp at sea level; 1600 hp at the site (Navajo Station). The SUTC-1610 engine, normally rated at 2500 hp at sea level, will be derated to 83 per cent of sea level rating.

This particular station of El Paso Natural Gas Company is on the main transmission line, which extends almost directly west. It connects with the Pacific Gas and Electric system at the California border, supplying gas to the San Francisco area.

Pipeliner specializes on shorter runs, effectively uses Cleveland 320 trencher and 190 backfiller

On a 31-mile, 36-inch gas line for Natural Gas Storage Co. of Illinois, these two Clevelands—a "320" trencher and a "190" backfiller—were effectively employed. The line runs from the company's storage and compressor station at Herscher to a tie-in point near Devine on Texas-Illinois' main line. Construction was done by Contracting and Materials Company of Evanston, builders of many short length and smaller diameter lines in the frequently difficult pipelining conditions encountered in the Chicago area. Today, pipelines of all sizes and lengths—long and short, large diameter and small—are being more efficiently dug by Cleveland 320's and better backfilled by Cleveland 190's.

Good Everywhere

THE CLEVELAND TRENCHER COMPANY

20100 St. Clair Avenue • Cleveland 17, Ohio

PIPE LINE MICROWAVE SYSTEMS

August, 1956

Here's where the more than 17,000 miles and 700 stations are located, according to the latest Petroleum Engineer Survey

(Numbers in first column refer to separate Microwave Map No. 2 included with this issue as special supplement)

Map No.	Name of Company Owning and/or Operating System	Date In Service	From	To	Length Miles	No. Of. Stations	Freq. Band	No. of Channels
1	American Oil Pipe Line Co.	1951	Snyder, Texas	Eldorado Texas	143	9	6700	7
2	Atlantic Seaboard Corporation	U. C.	Standardsville, Va.	Criglersville, Va.	100	3	2000	—
3	Buffalo Pipe Line Corporation	1954	Caledonia, N. Y.	Marrowlock Hill, N. Y.	19	2	960	1
4	Colorado Interstate Gas Co.	1954	Colorado Springs, Colo.	Keyes, Oklahoma	281	7	2000	3
5	El Paso Natural Gas Company (San Juan System)	1952	Farmington, N. Mex.	Topock, Arizona	450	11	6700	4
5	El Paso Natural Gas Company (Permian System)	1953	Midway, Texas	Jal, N. Mexico	287	13	2000	21
5	El Paso Natural Gas Company (Western System)	1954	El Paso, Texas	Farmington, N. Mex.	478	12	2000	4
26	General Petroleum Corp.	1955	Santa Fe Springs, Cal.	Brea, California	15	2	960	1
6	Humble Pipe Line Company	1953	Houston, Texas	Kempner, Texas	450	19	6700	3
7	Industrial Gas Supply Corp.	1955	Houston, Texas	Alcomag, Texas	20	2	6700	10
8	Interstate Petroleum Communications, Inc. (Shell P. L.)	1951	Cushing, Okla.	Elk City, Oklahoma	160	8	6700	3
9	Atlantic—Sinclair System	1949	Philadelphia, Pa.	Reading, Pa.	70	5	2000	6
9	Atlantic—Sinclair System	1954	Philadelphia, Pa.	Pittsburg, Pa.	460	23	2000	9
10	Michigan Wisconsin Pipe Line Co.	1954	Hawsford, Texas	Detroit, Michigan	1540	59	2000	6
11	Mid Valley Pipe Line Company	1950	Longview, Texas	Lima, Ohio	1000	42	6700	10
12	Natural Gas Pipe Line Company of America	1953	Downers Grove, Ill.	Aurora, Illinois	20	2	6700	13
13	Natural Gas Storage Company of Illinois	1953	Herscher, Illinois	Cabery, Illinois	15	2	6700	2
14	New York State Natural Gas Corporation	1955	Syracuse, N. Y.	Utica, N. Y.	60	3	6700	2
15	Ohio Oil Company	U. C.	Findlay, Ohio	Bridgeport, Illinois	340	17	6700	24
16	Oklahoma Mississippi River Products Pipe Line (Sunray)	1952	Purcell, Oklahoma	Ada, Oklahoma	82	5	960	1
17	Oklahoma Natural Gas Company	1954	Muskogee, Oklahoma	Chickasha, Okla	220	11	2000	15
18	Panhandle Eastern Pipe Line Co.	1952	Kansas City, Mo.	Tuscola, Illinois	400	18	6700	9
19	Plantation Pipe Line Company	1953	Bremen, Georgia	Athens, Tennessee	156	7	2000	13
20	Platte Pipe Line Company	1954	Casper, Wyoming	Wood River, Illinois	1007	44	6700	9
21	Richfield Oil Corporation	1953	Los Angeles, Calif.	Sulphur Mtn., Calif.	60	3	6700	2
21	Richfield Oil Corporation	U. C.	Anaheim, Calif.	Bakersfield, Calif.	223	11	2000	24
22	Salt Lake Pipe Line Company	1952	Salt Lake City, Utah	———	35	2	960	4
23	Service Pipe Line Company	U. C.	Bretch, Oklahoma	El Reno, Okla.	90	4	6700	5
24	Sinclair-Continental System	U. C.	Ponca City, Okla.	Houston, Texas	760	29	6700	85
25	Sinclair Pure System	1953	Cushing, Okla.	Independence, Kans.	190	9	6700	24
25	Sinclair Pure System	1953	Independence, Kans.	Salisbury, Missouri	260	13	6700	23
25	Sinclair Pure System	1953	East Pittsburgh, Pa.	McDonald, Pennsylvania	20	2	6700	5
25	Sinclair Pure System	1954	Salisbury, Missouri	East Chicago, Indiana	475	21	2000	24
39	Sinclair Pipe Line Company	U. C.	Clinton, Ohio	East Pittsburgh, Pa.	90	5	2000	5
27	Standard Oil Company of Indiana (Products Pipe Line Dept.)	1954	Morehead, Minnesota	Mandan, North Dakota	200	8	2000	4
28	Sun Pipe Line Company	1953	Hoffman, Texas	Humble, Texas	15	2	960	1
28	Sun Pipe Line Company	1955	Sour Lake, Texas	Saratoga, Texas	13	2	960	1
28	Sun Pipe Line Company	1955	Barbers Hill, Texas	Liberty, Texas	18	2	960	2
29	Tennessee Gas Transmission Co.	1955	Kinder, Louisiana	Oakdale, Louisiana	23	2	6700	2
30	Texas Company	1953	Salem, Illinois	Kaskaskia, Illinois	20	2	960	2
31	Texas Eastern Transmission Corp.	1954	Shreveport, La.	Linden, New Jersey	1400	57	2000	8
32	Texas Gas Transmission Corp.	1950	Guthrie, Louisiana	Sharon, Louisiana	45	3	6700	5
32	Texas Gas Transmission Corp.	U. C.	Owensboro, Kentucky	Lake Charles, La.	900	33	2000	—
33	Texas Illinois Natural Gas Pipe Line Company	1952	Houston, Texas	Chicago, Illinois	1004	40	6700	9
34	Transcontinental Gas Pipe Line Corporation	1952	Falfurrias, Texas	Newark, New Jersey	1760	62	2000	7
35	Trunkline Gas Company	1954	Houston, Texas	Tuscola, Illinois	1000	32	2000	8
36	United Gas	1953	Jackson, Miss.	Montpelier, La.	126	6	2000	8
37	Union Oil Company	1955	Torrey Hill, Calif.	Mulholland, Calif.	35	3	2000	4
38	Wilcox Trend Gathering System, Inc.	1954	Cuero, Texas	Mineral, Texas	62	4	6700	5

New Canadian Mill Will Roll 36-in. Pipe

Although it will not even be in production until next winter, the latest pipe mill to be built in Canada has already received two substantial orders for large diameter line pipe. Welland Tubes, Ltd., a joint creation of Page-Hersey Tubes, Ltd., and The Steel Company of Canada, Ltd., is being established at Welland, Ontario, where the Page-Hersey plant is situated. It is capable of rolling pipe up to 16-in. diameter, but the new mill will handle 36-in., not now available in Canada.

Manual Gives Useful Tips On Poisonous Snakes

Do you know that . . .

Poisonous snakes are widespread — they inhabit all 48 states and can be found within minutes of Chicago's Loop or New York's Times Square.

People still die from snake bite — antibiotics are of no use against snake bite venom. Bites by large poisonous snakes on the head, shoulders, or trunk are usually fatal.

Snakes can't hear — so you can shout for help as long as you stand still. They have excellent eyesight and are sensitive to ground vibrations.

Once bitten, don't try to kill the snake — movement speeds up blood circulation and spreads the venom more rapidly.

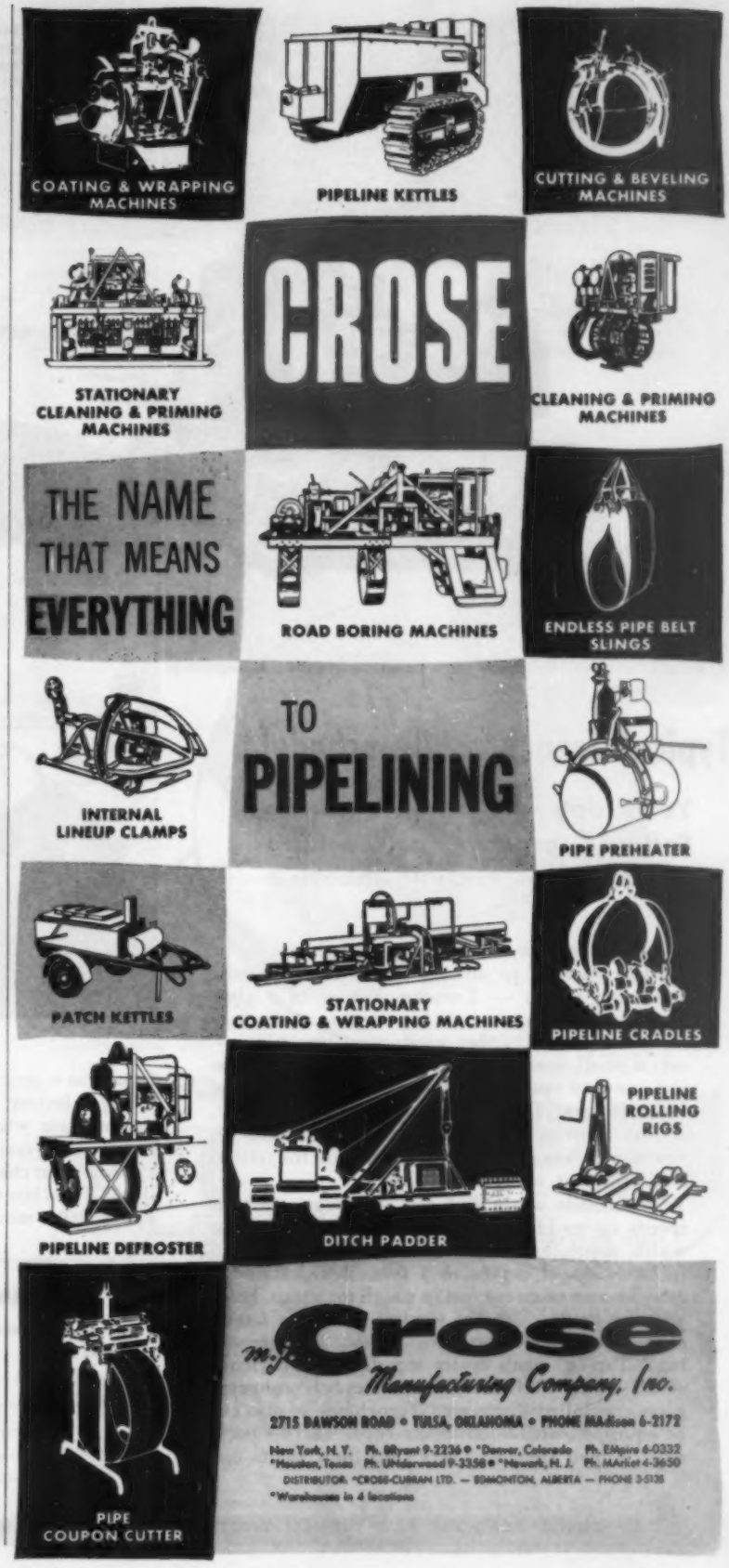
Rattlesnakes don't always rattle a warning — they may have lost their rattles or water may fill the spaces between rattles and muffle the sound.

Alcohol is no snake bite remedy — but drink as much water as you can, since swallowing may be difficult later.

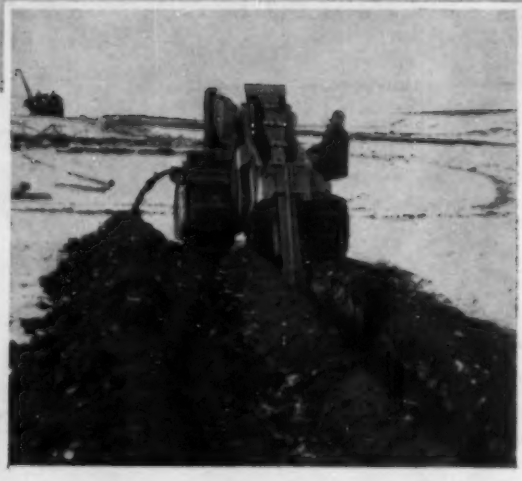
These points and a wealth of helpful information are contained in a new "Snake Bite Manual," just published by the National Safety Council.

The manual provides detailed instruction, with many photographs, on how to identify poisonous snakes, where they are usually found, safe practices, and protective clothing. A chapter is devoted to field first aid, giving step-by-step treatment of snake bites. Another section provides information of particular interest to medical directors of companies that have field workers in snake-infested areas.

Prepared primarily for the use of public utility linemen, the manual also would be useful in all fields which send workers into off-road terrain, such as oil well drilling, pipe line work, lumbering, and railroad maintenance of way. Although snakes as a rule do not inhabit areas serviceable to man, the search for new resources, the extension of communication and transportation, and the reclamation of many areas increase the hazard of snake bite.


COATING & WRAPPING MACHINES
PIPELINE KETTLES
CUTTING & BEVELING MACHINES
STATIONARY CLEANING & PRIMING MACHINES
CROSE
CLEANING & PRIMING MACHINES
THE NAME THAT MEANS EVERYTHING
ROAD BORING MACHINES
ENDLESS PIPE BELT SLINGS
INTERNAL LINEUP CLAMPS
TO PIPELINING
PIPE PREHEATER
PATCH KETTLES
STATIONARY COATING & WRAPPING MACHINES
PIPELINE CRADLES
PIPELINE DEFROSTER
DITCH PADDER
PIPELINE ROLLING RIGS
PIPE COUPON CUTTER
M. J. Crose Manufacturing Company, Inc.
2715 DAWSON ROAD • TULSA, OKLAHOMA • PHONE MAdison 6-2172
New York, N. Y. Ph. Bryant 9-2236 • *Denver, Colorado Ph. EMpire 6-0332
*Houston, Texas Ph. Underwood 9-3356 • *Newark, N. J. Ph. MArket 4-3650
DISTRIBUTOR: *CROSS-CURRAN LTD. — EDMONTON, ALBERTA — PHONE 3-5136
*Warehouses in 4 locations

Snow, winter temperatures, and frozen ground didn't shut down this pipeline job. Digging 16 inches wide, 2 feet deep, Parsons Trenchmobile averaged 5,000 lineal feet of trench every 9-hour shift.



Typical Trenchmobile schedule:

***Yesterday* — pipe reclamation**
***Today* — production trenching**
***Tomorrow* — trouble-shooting**

When it comes to all-around usefulness — in pipeline spreads, or around refineries, terminals, producing plants — Trenchmobile is in a class by itself! It's big enough for digging gathering-lines, laterals, and other production trenching — yet, is small enough, fast, and mobile for economical one-man operation on scattered, small-yardage work. It travels from job to job under its own power, drives over highways, cross-country, through towns at 12.6 m.p.h. There's no waiting for trailer, no loading or unloading delays.

Trenchmobile works fast, too. It opens trench at speeds up to 14.5 feet per minute, depending on width, depth, and soil conditions — digs 8 to 16 inches wide, at depths to 5 feet. Positive down-crowd boom starts cut fast in tough materials, holds accurate grade — makes vertical set-ins on lateral connections, undercuts cross-pipes. Self-sharpening, "Tap-In" teeth assure top digging efficiency at all times. Shiftable, reversible belt conveyor gives controlled discharge. Trenchmobile also can be equipped with 6-foot blade (optional) — backfills its own trench. There's no limit to its usefulness as a general-utility trencher, or as an auxiliary production unit. Ask Parsons distributor to demonstrate what it will do for you. Call him today — or mail coupon for latest Trenchmobile catalog. Also check Parsons complete line of heavy-duty Trenchliners® — wheel and ladder-types, full crawler-mounted.

PARSONS COMPANY, Newton, Iowa *(Koehring Subsidiary)*

Send us: ☐ spec. sheet ☐ catalog on Model 88 Trenchmobile.

NAME_____

TITLE_____

COMPANY_____

DIVISION_____

STREET_____

CITY, STATE_____

P882 PE

CHECK PARSONS FOR TRENCH WIDTHS FROM 8 TO 72 INCHES . . . DEPTHS TO 17 FEET

PIPE LINE PERSONALS

Frank B. Wright . . . vice president, celebrated his 44th anniversary with Southern Counties Gas Company. He joined Southern in 1912 and was elected vice president and director in 1950.

Edward B. Patterson . . . appointed Orange County division sales manager and **Harold B. Kirk** . . . succeeds him as manager of the natural gas bureau. Patterson replaces **H. W. Anderson** . . . resigned. With Southern Counties since 1937, Patterson served in various capacities and was named sales supervisor of the gas company's Harbor Division in 1951. Kirk joined Southern in 1938, becoming domestic sales supervisor of its northern division in 1940.

D. C. Benson . . . promoted from superintendent of measurement and research of Texas Gas Transmission Corporation, to director of planning and research. **W. A. Johnson, Jr.,** from superintendent of the pipe line department to general superintendent.

Charles W. Brown . . . from assistant superintendent of gas measurement to

D. C. Benson

W. A. Johnson

J. W. Carneal

C. W. Brown

superintendent of that department. **James W. Carneal** . . . from industrial representative in sales and customer relations to assistant director of that department.

Benson has been with the company 22 years. Johnson joined a predecessor company in 1945, and succeeds **A. L. Roberts** . . . recently elevated to a Texas Gas vice presidency. Brown has been with Texas Gas since 1949, and has been assistant superintendent of gas measurement since 1955. Carneal has been with Texas Gas since 1949.

Judge Arthur Kline . . . Cheyenne, Wyoming, took oath of office as a member of the Federal Power Commission for the term expiring June 22, 1961. The oath was administered by United States District Judge Ewing T. Kerr in Cheyenne. Judge Kline succeeds Commissioner **Claude L. Draper.**

Glen Grove . . . promoted to supervisor of compressor operations by Northern Natural Gas Company. With Northern since 1941, he was formerly staff assistant in the compressor department.

Jerry Guinane . . . transferred to the general department as gas storage engineer, from the engineering department. He began with Northern in 1954. **John Molloy** . . . promoted to supervisor of construction from office assistant in the compressor department. He has been with the company since 1939.

Lloyd Chambers . . . with Northern eight years, promoted to construction assistant in the compressor department, from clerk. **George Kenney** . . . promoted to staff assistant in the compressor department, from the dispatching department. He is a five-year employee.

J. W. Morton

John W. Morton . . . promoted to the position of assistant chief engineer for Cities Service Gas Company. With Cities Service since 1943 Morton has been engaged in general engineering duties and special projects in the company's Oklahoma City office.

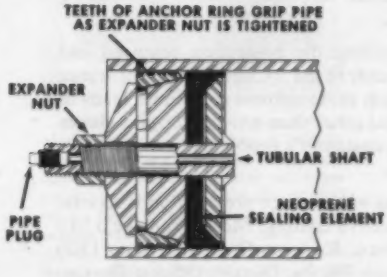
Kenneth E. Tappy . . . appointed superintendent of the Ohio Oil Company's Wyoming pipe line division, succeeding the late **Clare McElhinny.** Tappy joined Ohio Oil in 1933 and was former superintendent of the Lima, Ohio, pipe line division.

Here's a better way...

TO PLUG PIPE ENDS TEMPORARILY

In Order To:

- REPAIR PIPING
- ADD FITTINGS
- TEST PIPING & VESSELS
- PROPEL PIGS BY COMPRESSED AIR


TEETH OF ANCHOR RING GRIP PIPE AS EXPANDER NUT IS TIGHTENED
EXPANDER NUT
TUBULAR SHAFT
NEOPRENE SEALING ELEMENT
PIPE PLUG

*COLD WATER, NON SHOCK TEST MADE IN 12¾" O.D. STANDARD WEIGHT LINE PIPE.

WRITE FOR BULLETIN AND PRESSURE RATINGS OF ALL SIZES

T.D. Williamson, Inc.

P. O. BOX 4038 — TULSA 9, OKLAHOMA

REPRESENTATIVES: Houston • Pittsburgh • Plainfield, N. J. • Amarillo • Casper • Provo, Utah • Joliet, Illinois • Los Angeles • San Francisco • Bartlesville, Okla. • Edmonton • Toronto Calgary • Buenos Aires • Durban, Natal, South Africa

how to CUT CORROSION LOSSES

a report by Koppers Company, Inc.

Russell C. Stromquist
Corrosion Consultant

Recently, we were asked to recommend protective coatings in a plant on the West Coast. In analyzing their coating and enamel needs, we did our usual survey of the installation. After the survey, the customer's Chief Engineer remarked, "You fellows certainly go to a lot of trouble just to tell us what coating system we should use."

We do—because we know it is good for our customers and, therefore, good for us. Case history records prove clearly that careful study *before* making recommendations insures a better protective coating job at lower annual cost. In analyzing protective coating needs, our corrosion engineers follow a "pre-coating check list" based on experience on thousands of jobs.

* * *

The first step in the pre-application survey is a study of the environment. Specifically, you should always take into account the corrosive atmosphere: such factors as acid fumes, intense sunlight, salt air, etc. Physical environment—exposure to abrasion or impact—also plays an important part in the selection of an effective coating system.

The extent of temperature variation and expected minimum-maximum temperatures are important considerations, since the coating chosen must (a) resist low-temperature embrittlement, (b) resist high-temperature flow and (c) harden properly at service temperature.

The moisture environment too, is important in selecting protective coatings. Besides necessary water resistance, the coating should stand-up under pronounced wet-dry cycles.

A thorough cost analysis is a vital part of any pre-coating survey. Many factors are involved, varying in importance with the specific application. For example, total coating cost—made up of surface preparation and application costs—must be balanced against the cost of periodic maintenance. In some cases, the coated surfaces will not be accessible and coating-life will be a *direct* measure of the life of the material.

The cost of probable shut-down or loss of production time is perhaps one of the most important evaluations that must be made in intelligent selection of corrosion-preventing coating systems. Often, it outweighs the direct replacement costs of materials to be protected.

* * *

This pre-coating check list, detailing the protection required and under what circumstances, is a key factor in the exceptional performance of Koppers Bitumastic® coatings. Such thoroughness sometimes leads us to willingly recommend some material other than one of Koppers eleven basic Bitumastic coatings to solve a customer's problems.

* * *

In the next report, we will discuss why surface preparation is so vital to the life and economy of any protective coating. Meanwhile, we'd like to hear about your corrosion problems. Koppers Company, Inc., 1300 Koppers Bldg., Dept. 105H, Pittsburgh 19, Pa. District Offices: Boston, Chicago, Los Angeles, New York, Pittsburgh and Woodward, Ala.

KOPPERS

BITUMASTIC
REG. U. S. PAT. OFF.
COATINGS AND ENAMELS

To: THE PETROLEUM ENGINEER

P. O. Box 1589, Dallas

CHANGE MY ADDRESS, beginning

with the_____issue,

FROM:_____

_____

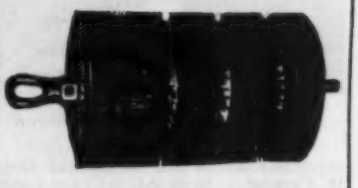
_____

TO:_____

_____

_____

MOLE
Pipeline Cleaner



for BETTER cleaning of
CRUDE LINES
PRODUCT LINES
NATURAL GAS LINES

FOR DETAILS WRITE

Pipeline Cleaners Co.
Fort Madison, Iowa

Personals

▸ **D. A. Hardesty** . . . elected assistant vice president of the Natural Gas Pipeline Company of America and its affiliate, Texas Illinois Natural Gas Pipeline Company. A 21 year veteran in the transmission industry, Hardesty is vice chairman of the employee relations section of the Southern Gas Association and vice chairman of the Employee Relations Committee of the Independent Natural Gas Association of America.

D. A. Hardesty

▸ **Roy A. Doman** . . . appointed chief engineer for New York State Natural Gas Corporation. He joined The Peoples Natural Gas Company in 1946 and was made chief civil engineer for New York State Natural in 1951.

▸ **Stuart F. Silloway** . . . named president of Pacific Northwest Pipeline Corporation. **C. R. Williams** . . . who directed Pacific operations since 1951, appointed vice chairman of the board of directors.

Silloway was formerly vice president for finance of The Mutual Life Insurance Company of New York. As president of Pacific, he will also be a director of both the pipe line company and its subsidiary, Northwest Production Corporation.

▸ **Arthur W. Manley** . . . elected vice president of Mississippi River Fuel Corporation. With Mississippi since 1949, Manley has served as secretary of the company, as well as assistant to the president and continues in his capacity of secretary.

C. J. Maurer . . . assistant treasurer, elected treasurer to succeed **Charles Shuttleworth** . . . retiring. Maurer joined the organization in 1947, and has been assistant treasurer since 1951. Shuttleworth has been with the company since its inception in 1929.

Re-elected were vice presidents **H. D. Graham, E. P. Kramer, R. V. Terry** and **R. W. Horner.**

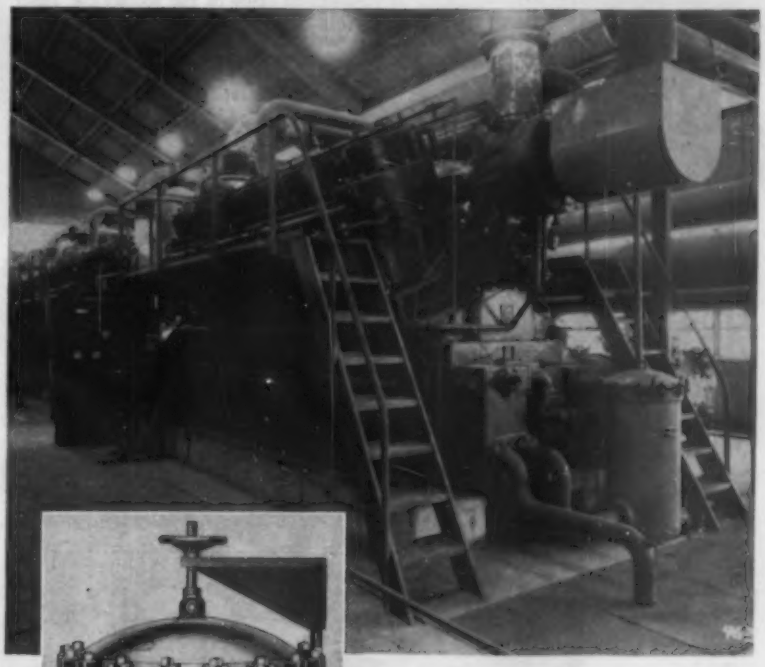
▸ **G. W. Horsley** . . . vice president of The East Ohio Gas Company since 1950, is now senior vice president. He joined East Ohio in 1915.

R. W. Ramsdell . . . named executive vice president of East Ohio. He is a former vice president, and current company director. **John H. Carson** . . . new vice president and general manager. He joined East Ohio in 1933, was appointed a director in 1949, and vice president in 1950.

A. H. Forbes . . . returned to East Ohio as a vice president. He joined East Ohio in 1936, and three years ago became vice president of the New York State Natural Gas Corporation. **Dr. F. E. Vandaveer** . . . director of the East Ohio laboratories became associate director of research for the Consolidated Natural Gas Company system.

▸ **Sam Phelps,** chief engineer of Interstate Oil Pipe Line Company, Shreveport, has accepted an assignment with Jersey Standard's West Germany affiliate as pipe line advisor. He will be responsible for the design and construction of a large diameter pipe line to extend from a tanker unloading terminal on the North Sea into the Ruhr Valley to handle Middle East and Venezuelan crude. The assignment will last from two to three years.

After Two Years Service- Clean as a Whistle Inside with NUGENT *Full-Flow* Filters



Nugent 1555 "Extended Area" Filter of the type used by El Paso at Midkiff. These filters are equipped with laminated crenulated fiber disc recharges which have had an average life of 2500 engine hours at the Midkiff Station. They remove solid particles as small as 2 microns but do not remove additives in detergent oils. Recharging requires only ten minutes.

Nine Ingersoll-Rand turbo-charged gas engine driven compressors at the Midkiff Station of El Paso Natural Gas Co. have been equipped with Nugent Filters since installation. The full-flow filtering provided by these filters has protected the bearings and kept these engine-compressors clean inside for well over two years. Service like this has resulted in many repeat orders from El Paso Gas Co. and other leading pipe line companies.

To give your engines and compressors the protection they deserve, specify Nugent *Full-Flow* Filtering. This means that *all* the oil in circulation passes through the filter every cycle before going to thet bearings . . . and it means that particles as small as microns are removed before they can damage precision parts. Write for helpful descriptive literature today.

NUGENT TRADE MARK Est. 1897

Wm. W. *Nugent* & Co., Inc.
3424 Cleveland Street Skokie, Illinois

Oil Filters, Oiling and Filtering Systems, Telescopic Oilers, Oiling Devices, Sight Feed Valves, Flow Indicators . . . *Representatives in Principal Cities*

Personals

▸ **M. E. (Bones) Foster** . . . retired from Phillips Petroleum Company and Phillips Pipe Line Company, after more than 32 years of service, to open an office in Bartlesville, Oklahoma, as consultant in the general field of supply, distribution, and transportation in the oil industry. With Phillips he served in various capacities, including assistant general sales manager, company coordinator, manager of the supply and transportation department, and president of Phillips Pipe Line Company.

M. E. Foster

▸ **C. L. Wilson** . . . transferred to Mineral Wells, Texas, as superintendent to replace **James J. Dougherty** . . . retired. With Service since 1924, Wilson was formerly district superintendent at Kearney, Nebraska.

Dougherty joined the company in 1916 and is the first Service employee to retire with 40 years service.

▸ **Allen D. Schrodt** . . . formerly sales coordinator, Southern Union Gas Company, named director of the promotion, advertising and research (PAR) program of the American Gas Association. He succeeds **Otto E. Zwanzig** . . . resigned to become general sales manager of the British Columbia Electric Company, Ltd.

▸ Retired Navy Captain **John C. Woelfel** has joined the Richfield Oil Corporation as manager of tanker operations in the firm's marine department.

E. E. Hurley

▸ **E. E. Hurley** . . . assigned division chief engineer, east Texas division of Service Pipe Line Company.

He joined Service in 1946 and became a senior engineer with the company's general engineering department in 1954.

▸ **J. M. Evans** was appointed assistant vice president of Standard Oil Company of California. With the company since 1915, he is succeeded as chief engineer and head of the company's engineering department by **E. S. Warner**, assistant chief engineer since 1947.

AN-SPEC

EXPERIENCED

ENGINEERING

- COMPREHENSIVE SURVEYING
- HIGHEST QUALITY MATERIALS
- COMPLETE CONSTRUCTION

Cathodic protection against corrosion is a job for specialists . . . specialized engineering and other services. Pipe Line Anode Corporation offers every service — by experienced and skilled personnel — for complete cathodic protection. AN-SPEC magnesium anodes — their high purity guaranteed — complete the unbeatable combination of highest quality service and product.

ANODE SPECIALISTS
AN-SPEC

PIPE LINE ANODE CORPORATION

P. O. BOX 996 • TULSA, OKLAHOMA

2230 Magnolia Street
Birmingham, Alabama

11525 East Colfax
Denver (Aurora), Colorado

858 Wilson Avenue
Newark, New Jersey

912 West 11th
Houston, Texas

Distributor: Crose-Curran, Ltd.
Edmonton, Alberta—Phone 3-5135

Brazos Acquires Construction Equipment of Anderson Bros.

Brazos Equipment Rental Company, Houston, has acquired the pipe line contracting assets of Anderson Bros. Corporation. Announcing details of the transaction to clarify previous reports, Paul E. McDaniel, owner of Brazos Equipment Rental, Houston, said that the firm is now owner of the largest and most complete stock of pipe line contracting equipment ever assembled, representing a multi-million dollar inventory.

McDaniel, who is also president of Brazos Engineering Company, Inc., Paul E. McDaniel, Inc., and other companies, explained that premature reports referring to these companies as receiving the assets of Anderson Bros. Corporation were in error, probably due to the close similarity of company names.

The pipe line construction equipment acquired by Brazos Equipment Rental is now located in Texas, Montana, Wyoming, Minnesota, Louisiana, Ohio, and North Carolina and comprises about every type used for pipe line laying, land clearing, road building, and other heavy construction. Available to contractors on a rental basis; or on a rental/purchase, outright sale, or trade arrangement if desired, the equipment can be moved to any job in the U. S., Canada, or Mexico.

Machinery of nearly any size and make can be rented, from fill-in units a contractor may need to augment his own equipment up to complete spread equipment. Included are more than 85 crawler tractors, generators from 10-kw to 1000-kw, winches, welding equipment, and other machinery.

General manager of the Brazos Equipment Rental Company is Don Sharp. Main office and yard of the company are at 3200 Wheeler Street, Houston. Other personnel include L. J. Knox, field representative, and M. D. Gier, shop superintendent.

Pipeliners like Gaso Pumps

P.L. G.P.

Pipe line engineers like Gaso Pumps because Gasos offer such complete assurance of every quality an engineer looks for in pumps. No doubts, worries or uncertainties when the specifications call for the pumps that are *first in their field!*

FIG. 1931—for suction service on large capacity gravity lines and low-pressure large-volume transfer service. Capacities, 291 to 838 GPM at pressures from 225 to 125 PSI.

GASO PUMP & BURNER MFG. CO.
Tulsa, Oklahoma • *EXPORT OFFICE:* 149 Broadway, New York

FIRST IN THEIR FIELD

GASO PUMPS
for every oil industry need

DISTRIBUTORS
W. L. SOMNER COMPANY, Shreveport, Louisiana • Odessa, Texas • Tinsley, Mississippi • Brookhaven, Mississippi
POWER PUMPS, INC., Long Beach, California
PEDDLERS, INC., Houston, Texas
PUMP ENGINEERING CO., Wichita Falls, Texas
LUFKIN FOUNDRY & MACHINE CO., Casper, Wyoming
LUFKIN MACHINE CO., Ltd., Edmonton, Alberta

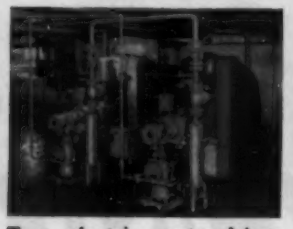
GET GASO DEPENDABILITY IN WATER FLOODING, TOO

TENNESSEE GAS employs at Coudersport storage

Ingersoll-Rand KVG gas-engine compressors on natural gas storage and transmission service at Tennessee Gas Transmission Company's Coudersport (Pa.) station. Each unit is rated 1320 hp.

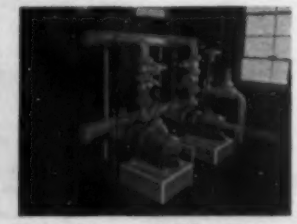
OTHER I-R EQUIPMENT AT COUDERSPORT STATION

PSVG-8 gas engine, rated 544 hp, driving a 380-kw synchronous generator for supplying plant power.



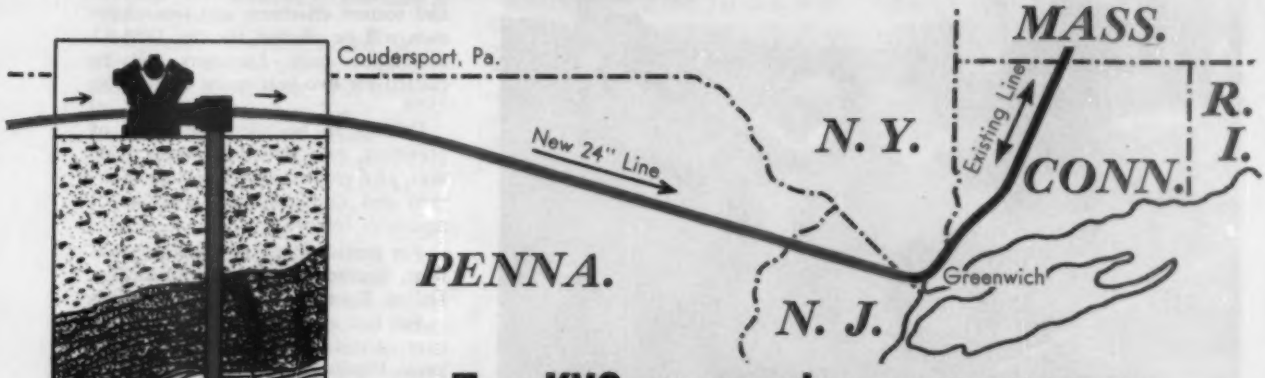
Two electric motor-driven Type ES compressors supplying 250-psi starting air for the KVG compressors.

Two Class LFV centrifugal pumps supplying jacket cooling water for the KVG's; each pump rated 2200 gpm, 60-ft. head.



Two Class RVL Motorpumps supplying jacket cooling water for the PSVG gas engine; each pump rated 312 gpm, 59-ft. head.

four-cycle flexibility and transmission station



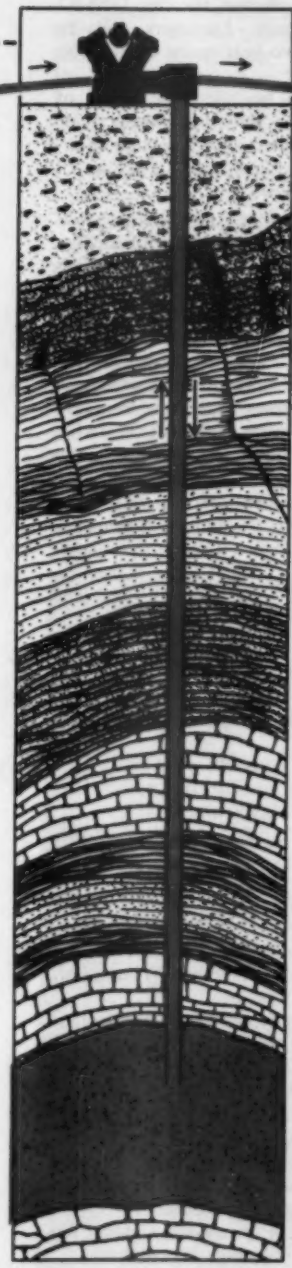
Ten KVG gas-engine compressors on unusual dual-purpose job serve New York City area

Billions of cubic feet of southwestern gas are now being inhaled by Pennsylvania's once-productive Hebron gas field, to be exhaled through a new 250-mile pipeline when winter weather swells New York City's gas needs. This new system is a part of the growth of Tennessee Gas Transmission Company, and the lungs of the system are ten Ingersoll-Rand KVG gas-engine compressors totalling 13,200 hp at TGT's Coudersport (Pa.) pipeline station.

These compressors inject the gas into the underground storage field, and later boost it through the line to the consumers. Compressors on such a double-duty job must operate over a wide range of speeds and loads — a need well met by the inherent flexibility of I-R four-cycle machines. (For example, these KVG's operate from 300 to 1600 psig intake, and 900 to 2500 psig discharge.)

These V-angle, 4-cycle units actually deliver smooth power without skipping or stalling, all the way from full load to no load, from half speed to full speed, and with generous reserve for temporary overloads. All this, plus the proven dependability and trouble-free performance of I-R compressor cylinders and valves.

For sustained top performance under the most demanding conditions, it pays to specify Ingersoll-Rand 4-cycle gas-engine compressors. Ask your I-R representative to show you how these heavy-duty units can make long-range savings in your compression costs.



Cross-section of underground storage field, where vast quantities of natural gas are injected into porous sands capped by thousands of tons of rock and shale.

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

4-CYCLE

COMPRESSORS • PUMPS • AIR AND ELECTRICAL TOOLS • VACUUM EQUIPMENT • ROCK DRILLS • CONDENSERS • GAS AND DIESEL ENGINES

"because BANTAM does so many pipeline jobs — so fast!"

Carrier Mounted Capacities up to 14,000 lb.

Crawler Mounted Hoe digs to over 15-ft. depth

Self-Propelled For complete one-man operation

That's why BANTAMS are making more and more friends—and more repeat buyers among pipeline contractors.

You can bank on this: BANTAM's versatility lets you handle every assignment quickly and at lowest cost. Digging trenches and bellholes, loading and placing pipe, backfilling and driving piles—these are only a few of the jobs BANTAMS are doing up and down the pipelines—with 9 different fast-change attachments.

Whether your next job is big or little, across the road or across the country, try a BANTAM! You'll agree, it's the handiest rig you can own. Choose the model to fit your needs exactly—Crawler, Carrier or Self-Propelled! Let us give you more money-saving facts about BANTAMS in pipeline work. Use the coupon.

SCHIELD Bantam Co.

286 Park St., Waverly, Iowa, U.S.A. D-66

WORLD'S LARGEST PRODUCER OF TRUCK CRANES AND EXCAVATORS

Send data on BANTAM checked below:
☐ Carrier Mounted ☐ Crawler Mounted ☐ Self-Propelled

Name..... Title.....

Company.....

Address.....

City..... State.....

AGA Officers and Directors Nominated

The general nominating committee of the American Gas Association has presented a list of leading executives from gas utility, pipe line, and manufacturer company members as its slate of general officers, directors, and section officers for submission at the AGA annual convention. Association officers and section chairmen and vice chairmen will be elected for the 1956-57 association year. Directors will be elected for two-year terms expiring in 1958.

Officers to be filled are those of president, two vice presidents, treasurer, 16 directors, and 11 section chairmen and vice chairmen. The list of nominees follows:

For president: C. H. Zachry, president, Southern Union Gas Company, Dallas, Texas.

For first vice president: A. W. Conover, president, Equitable Gas Company, Pittsburgh, Pennsylvania.

For second vice president: Robert W. Otto, chairman of the board, Laclede Gas Company, St. Louis, Missouri.

*For Treasurer: Vincent T. Miles, treasurer, Long Island Lighting Company, Mineola, New York. Dean H. Mitchell, president, Northern Indiana Public Service Company, Hammond, Indiana, becomes a director upon completion of his present term as association president. Newly-nominated and renominated directors are:

John B. Balmer, president, John Wood Company, New York.

Everett J. Boothby, president, Washington Gas Light Company, Washington, D. C.

*F. D. Campbell, president, New England Gas and Electric Association, Cambridge, Massachusetts.

Marvin Chandler, president, Northern Illinois Gas Company, Aurora, Illinois.

Carl E. Cloud, president, Mid South Gas Company, Little Rock, Arkansas.

*Stuart Cooper, president, Delaware Power & Light Company, Wilmington, Delaware.

C. H. Gueffroy, president, Portland Gas & Coke Company, Portland, Oregon.

J. J. Hedrick, president, Natural Gas Pipeline Company of America, Chicago, Illinois.

Robert A. Hornby, executive vice president, Pacific Lighting Corporation, San Francisco, California.

Julius Klein, president, Caloric Appliance Corporation, Philadelphia.

*Donald C. Luce, president, Public Service Electric & Gas Company, Newark, New Jersey.

*Walter T. Lucking, president, Arizona Public Service Company, Phoenix,

Arizona.

George T. Naff, president, Texas Eastern Transmission Corporation, Shreveport, Louisiana.

#John C. Parrott, president, Roanoke Gas Company, Roanoke, Virginia.

*C. P. Rather, president, Southern Natural Gas Company, Birmingham, Alabama.

*E. H. Tollefson, president, Hope Natural Gas Company, Clarksburg, West Virginia.

Chairman accounting section: W. D. Sweetman, superintendent, customers accounting department, The Peoples Gas Light & Coke Company, Chicago. Vice chairman: D. W. Peterson, secretary and treasurer, Minneapolis Gas Company, Minneapolis, Minnesota.

Chairman general management section: Leslie A. Brandt, vice president, The Peoples Gas Light and Coke Company, Chicago. Vice chairman: John H. Wimberly, president, Houston Natural Gas Corporation, Houston, Texas.

Chairman industrial and commercial section: J. Robert Delaney, manager, gas sales, The Cincinnati Gas & Electric Company, Cincinnati, Ohio. Vice chairman: Roy E. Wright, director of gas sales, NEGEA Service Corporation, Cambridge, Massachusetts.

*Re-nominated.

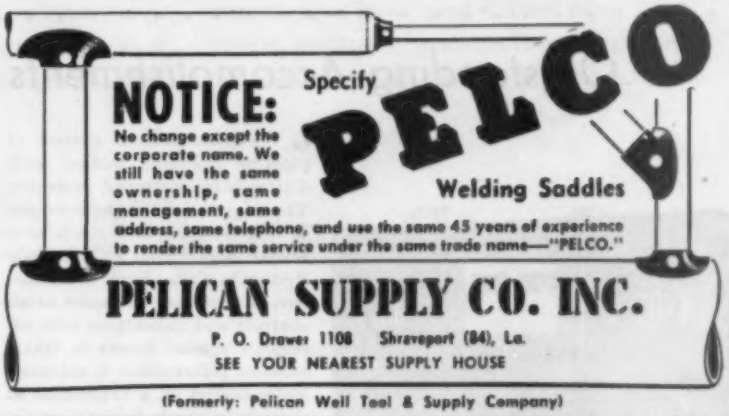
#Nominated to serve out term of Robert W. Otto, expiring October, 1957.

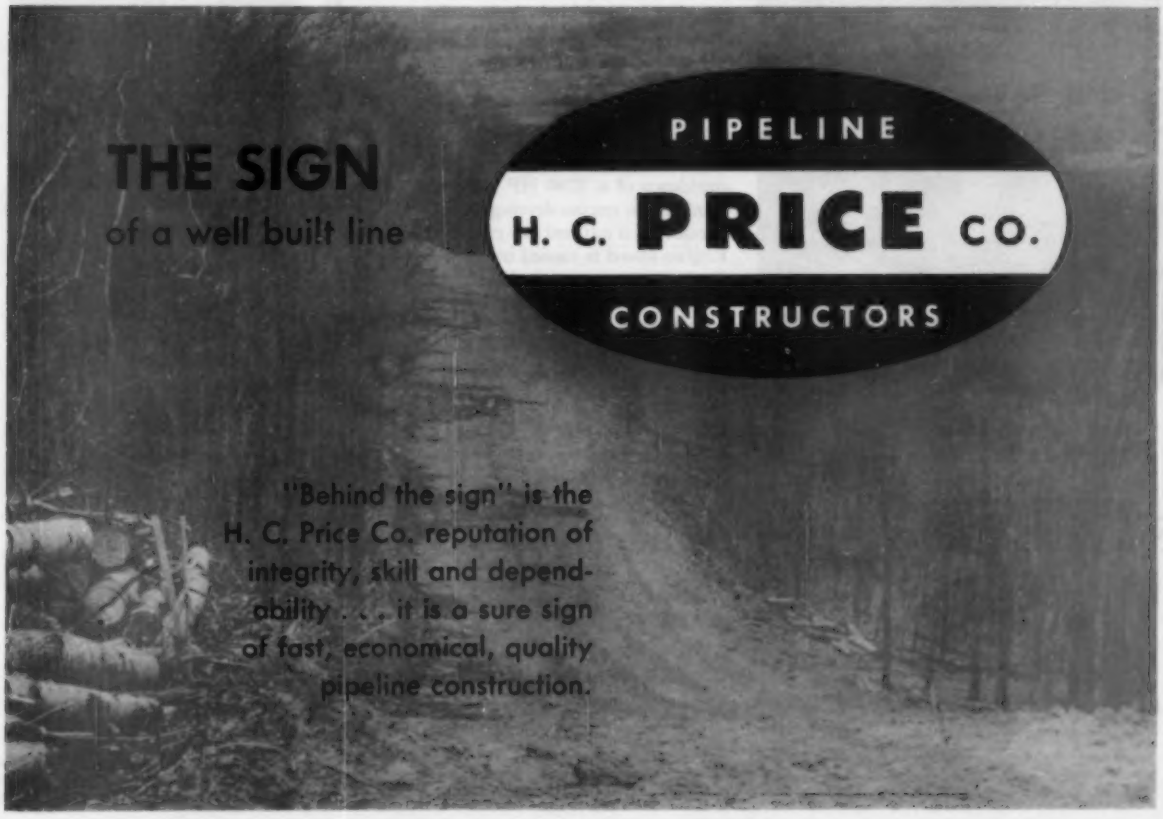
Chairman operating section: Grove Lawrence, vice president, Southern California Gas Company, Los Angeles, California. Vice chairman: Victor F. Bittner, assistant chief technical engineer, The Peoples Gas Light & Coke Company, Chicago. Second vice chairman: Herbert C. Jones, gas engineer, New England Electric System, gas division, Malden, Massachusetts.

Chairman residential gas section: W. D. Williams, vice president in charge of sales, New Jersey Natural Gas Company, Asbury Park, New Jersey. Vice chairman: A. G. Bur, vice president in charge of sales, Wisconsin Public Service Corporation, Green Bay, Wisconsin.

Allen Schrodt Director AGA Par Program

Allen D. Schrodt, formerly sales coordinator, Southern Union Gas Company, Dallas, Texas, has been named director of the promotion, advertising and research (PAR) program of the American Gas Association, it was announced by C. S. Stackpole, managing director of AGA. Schrodt assumed his new duties at AGA, headquarters in New York City on July 10. He succeeds Otto E. Zwanzig, who resigned as director of PAR to join the British Columbia Electric Company, Ltd., in Vancouver, British Columbia.


NOTICE:
No change except the corporate name. We still have the same ownership, same management, same address, same telephone, and use the same 45 years of experience to render the same service under the same trade name—"PELCO."
Specify
PELCO
Welding Saddles
PELICAN SUPPLY CO. INC.
P. O. Drawer 1108 Shreveport (84), La.
SEE YOUR NEAREST SUPPLY HOUSE
(Formerly: Pelican Well Tool & Supply Company)

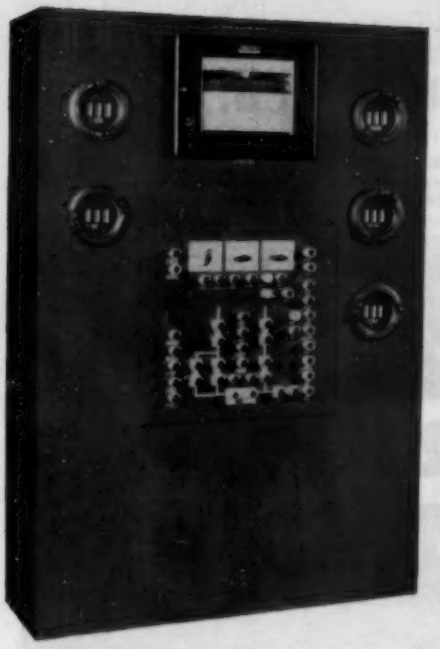

THE SIGN
of a well built line
PIPELINE
H. C. PRICE CO.
CONSTRUCTORS
"Behind the sign" is the H. C. Price Co. reputation of integrity, skill and dependability . . . it is a sure sign of fast, economical, quality pipeline construction.

Outstanding Accomplishments of
UNION CENTRALIZED TRANSPORT CONTROL

UNION Centralized Transport Control has been in successful operation on a number of pipelines and has proved highly dependable. It can give you reliable remote control and indications, and monitor the data for your entire pipeline from one central dispatching office. Among the many installations, two stand out for their unusual applications of UNION Centralized Control.

TYPEWRITER AND CONSOLE used in a UNION C.T.C. System.

Outstanding Accomplishments



UNION CONTROL PANEL for a gas-compressor station.

1. Complete remote control of pipeline pumping station with digital telemetering of variables. The information to be telemetered is incorporated into the Union Switch and Signal C.T.C. Code System in digital form. Transmission is protected the same as all controls and indications with assurance against errors in transmission. Information is automatically logged on a typewriter at periodic intervals, initiated on demand or initiated by upset conditions on the line. Entire systems can operate within 0 to 15 cycles minimum pulse rate to meet low-cost lease lines requisites.

2. Remote control of start-up, monitoring the operations and shutdown of a 3700 HP internal combustion engine driving a compressor on a natural gas pipeline. Engine speed is varied to control discharge pressure. Discharge controller set point controlled to a fineness of one part in 999 from remote location. Data telemetered digitally to main office by teletype.

UNION Centralized Transport Control can be used anywhere on pipeline layouts, gas distribution systems, gathering systems, tank farms and offshore installations. It has been thoroughly proved in service and is backed up by experience in centralized control covering more than 25,000 miles of long haul transportation. Write for booklet 1052 for information on your single or multiple station control requirements.

75 Years

1881 1956

OF EQUIPMENT AND SYSTEMS ENGINEERING . . . . .

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

Enough to run a pipe line from San Francisco to London

THE gas and petroleum transmission industries can take great pride in the gigantic jobs they've completed in recent years.

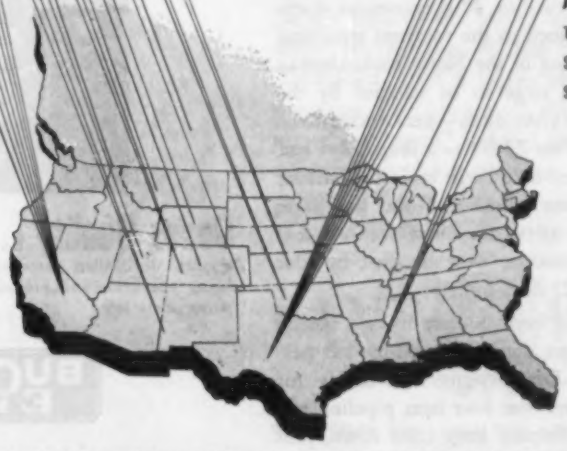
As a major supplier of large diameter steel line pipe, Kaiser Steel has been privileged to play an important part in these vast undertakings. In five years, enough line pipe of various diameters has been shipped from our Napa, California plant to run a pipe line from San Francisco to London.

Shown below is a partial list of major customers, who have used Kaiser Steel Line Pipe in scattered locations from New York to California, from Canada to Mexico.

CITIES SERVICE GAS CO.
NORTHERN NATURAL GAS COMPANY
PANHANDLE EASTERN PIPE LINE CO.
SINCLAIR PIPE LINE CO.
INTERPROVINCIAL PIPE LINE CO.
OKLAHOMA NATURAL GAS CO.
PLATTE PIPE LINE CO.
NATURAL GAS PRODUCERS, INC.
THE MONTANA POWER COMPANY
COLORADO INTERSTATE GAS CO.
ARAPAHOE PIPE LINE CO.
TRANS MOUNTAIN OIL PIPE LINE CO.
MOUNTAIN FUEL SUPPLY CO.
SOUTHERN UNION GAS CO.
EL PASO NATURAL GAS CO.
PACIFIC GAS & ELECTRIC CO.
STANDARD OIL COMPANY OF CALIFORNIA
UNION OIL COMPANY OF CALIFORNIA
RICHFIELD OIL CORPORATION
SOUTHERN COUNTIES GAS CO.
TIDE WATER ASSOCIATED OIL COMPANY
SOUTHERN CALIFORNIA GAS COMPANY

Kaiser Steel

GULF OIL CORPORATION
GULF REFINING COMPANY
PHILLIPS PETROLEUM CO.
PHILLIPS PIPE LINE CO.
TENNESSEE GAS TRANSMISSION CO.
THE TEXAS PIPE LINE COMPANY
PIONEER NATURAL GAS COMPANY
TRUNKLINE GAS COMPANY
TRANSCONTINENTAL GAS PIPE LINE CORP.
TEXAS EASTERN TRANSMISSION CORP.
UNITED GAS PIPE LINE COMPANY
ASIATIC PETROLEUM CORPORATION
THE PURE OIL COMPANY
SINCLAIR OIL CORPORATION
SHELL PIPE LINE CORPORATION



Steel Mill Products: plates • hot rolled strip and sheet • cold rolled strip and sheet • tin plate • continuous weld pipe • electric weld pipe • alloy and carbon bars • bar shapes • structural shapes semi-finished steels • pig iron • ingot molds • coke by-products • **Fabricating Division:** steel fabrication for construction, aircraft, missile and other industries • expanded fusion weld pipe reinforced concrete pipe • tanks • For specifications, write: **KAISER STEEL CORPORATION** • **Los Angeles** • **Oakland** • **Seattle** • **Portland** • **Phoenix** • **Denver** • **Tulsa** • **New York**

Eleven 22-B's help beat time, terrain, low temperatures on Canadian gas line

Majestic Contractors Ltd., a fast-growing, fast-moving Canadian construction company, recently completed a 226-mile pipeline from the gas fields near Coleville to Prince Albert in Saskatchewan. It was finished on time despite difficult terrain, tough river crossings, and sub-zero temperatures.

Eight of the eleven Bucyrus-Erie 22-B excavators working on the spread were assigned to the toughest trenching jobs. On the St. Louis crossing of the North Saskatchewan River, large boulders — too large to be handled by the suction dredge preparing the river ditch—were encountered in the path of the trench. Two 22-B's — a dragshovel and a clamshell — were positioned on a barge to do the boulder digging. On land, too, some sections of the line were underlaid with boulders of all sizes. These sections, and also road and railway approaches, were handled by four 22-B dragshovels and two 22-B clamshells.

This kind of performance from Bucyrus-Eries is typical on pipeline spreads. You get dependable on-the-job performance because Bucyrus-Erie designs and builds for quality every step of the way. For your next pipeline job, put Bucyrus-Eries to work helping keep costs down, jobs moving on schedule. Your nearby distributor has all the facts.

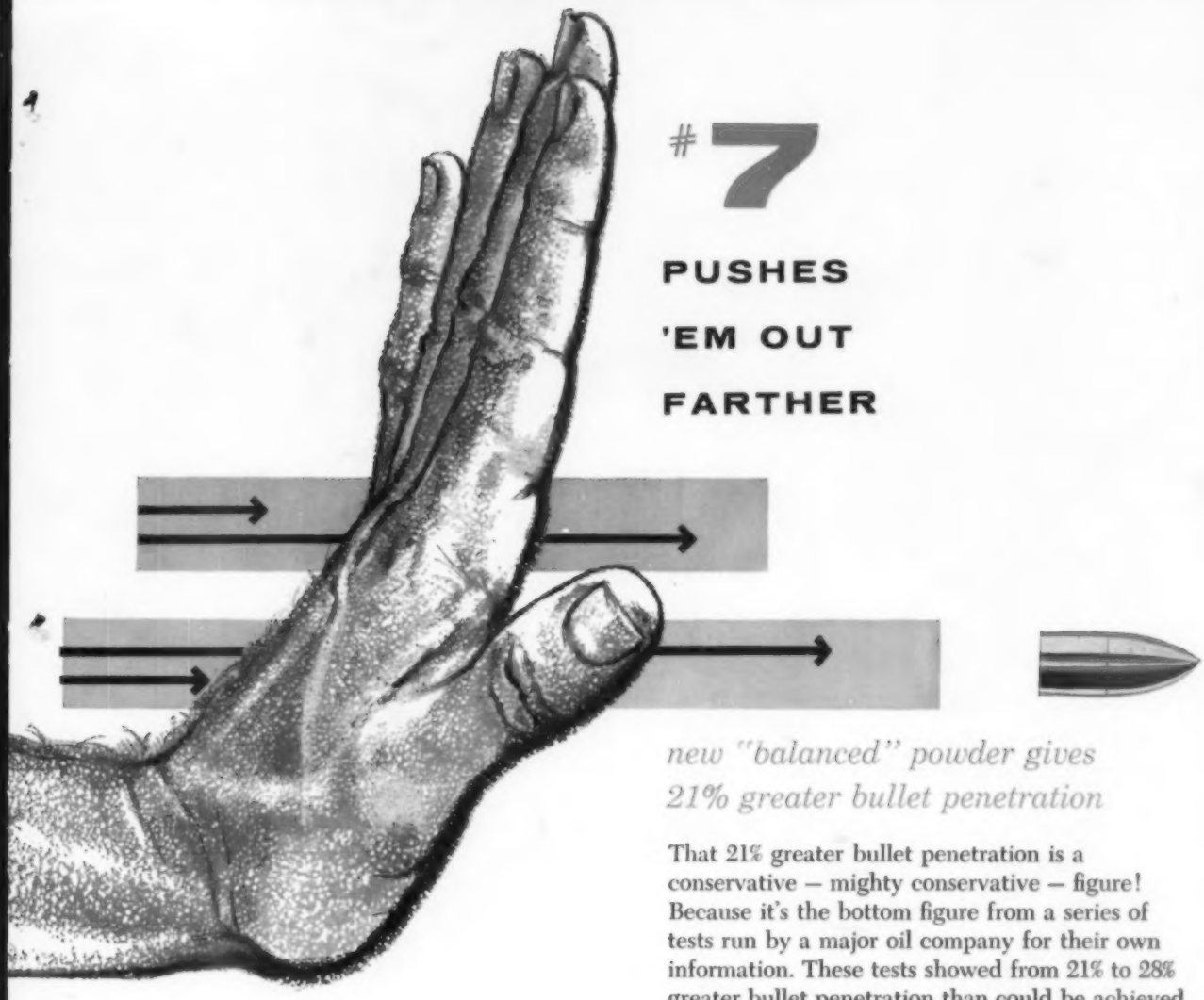
236E56

Bonus Quality Bucyrus-Erie starts with highest quality steel, then carefully flame hardens it like this to bring you gears and pinions that wear longer, keep maintenance costs low.

BUCYRUS ERIE

BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN



#7

PUSHES 'EM OUT FARTHER

new "balanced" powder gives 21% greater bullet penetration

That 21% greater bullet penetration is a conservative — mighty conservative — figure! Because it's the bottom figure from a series of tests run by a major oil company for their own information. These tests showed from 21% to 28% greater bullet penetration than could be achieved with Lane-Wells #3 powder — and that was powerful powder, as the same tests showed. Lane-Wells new #7 powder is a new answer to the age-old ballistics problem of how to get more power behind the bullet without increasing the strain on the gun. #7 has been so formulated and "balanced" that it burns slower, with lower peak pressure, but *longer* . . . thus building up a tremendous "push" behind the bullet that drives it deeper into the formation. And there's no price premium for #7 powder — just another example of Lane-Wells efforts to give better service.

Tomorrow's Tools — Today!®

LANE WELLS COMPANY

General Offices, Export Office, Plant • 5610 So. Soto St., Los Angeles 58

LOS ANGELES • HOUSTON • OKLAHOMA CITY • LANE-WELLS CANADIAN CO. IN CANADA • PETRO-TECH SERVICE CO. IN VENEZUELA

SAFETY

Is Under The Hat

Steel-toed shoes and a safety hat protect the one who wears them. But a program designed to prevent accidents will develop what's **under** the hat. After 33 years of intensive training, safety has become a habit with your Halliburton operator. It marks the manner in which he works, stamps the design of his tools and equipment, shapes him for top at-your-rig service. Last year, for example, he drove ninety million miles with an accident ratio of only .36 per hundred thousand . . . approximately one accident per three hundred thousand miles. This "under the hat" kind of safety is another good reason to choose Halliburton as one source for all six coordinated well completion services.

HALLIBURTON

OIL WELL CEMENTING COMPANY

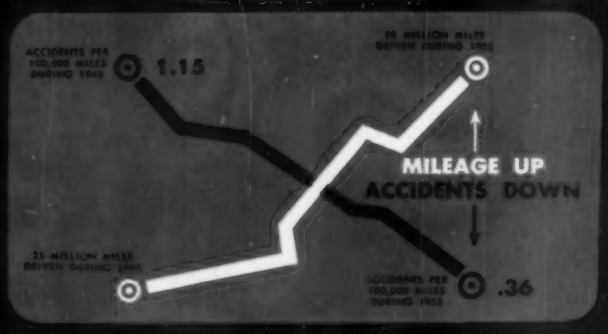
Duncan, Oklahoma

"We've Come A Long Way Safely"

ELECTRICAL WELL SERVICES

FORMATION FRACTURING

CEMENTING SERVICES



DRILL STEM TESTING

CHEMICAL SERVICES

CEMENTING EQUIPMENT